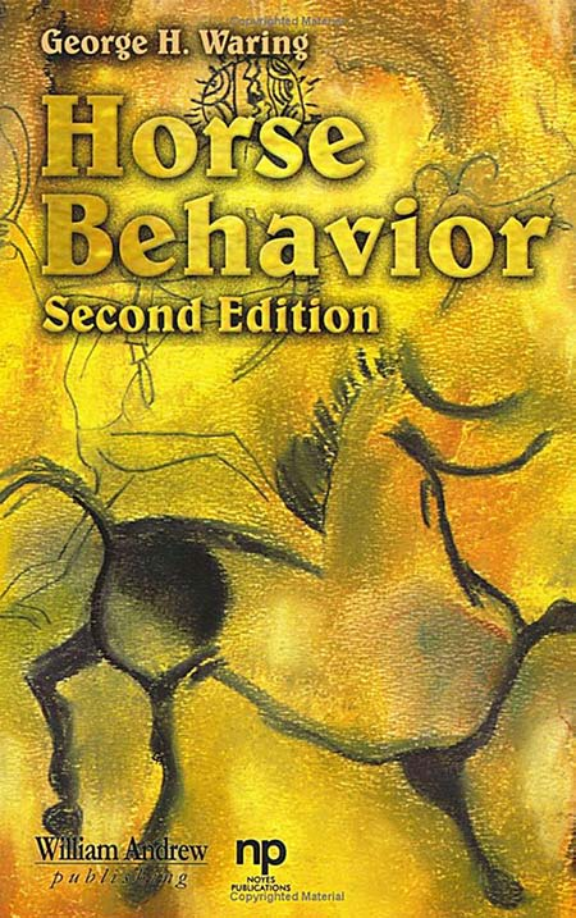


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HORSE BEHAVIOR

Second Edition

by

GEORGE H. WARING

Southern Illinois University
Carbondale, Illinois

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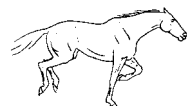
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This book is dedicated to my Family, near and far,
to Equine Researchers worldwide,
to the Equids of past and present,
and to God, who has blessed us all.

Preface



To the avid *horse enthusiast*, this book will provide a reference to scientific studies and a thorough overview of our understanding of horse behavior. Data from studies throughout the world are included. Sources of information are cited within the text and are listed in the Bibliography. To *veterinarians* and *students of veterinary science*, the book will provide a baseline of typical horse traits and contrast those with abnormalities encountered in equine care and medicine. To *animal scientists* and to *students of animal husbandry*, the content of the book will provide ethological guidance for successful management, handling, and production. And to *animal behaviorists*, *biologists*, and *students of natural history*, the book will provide insight into the behavioral biology and adaptations of a truly fascinating species—*Equus caballus*.

The book considers the horse, including ponies, under both domesticated and feral conditions. No attempt is made to also review the traits of the other equine species. Technical terms pertaining to behavior are clarified within the text. When using the volume as a reference, the Index and Table of Contents will be especially helpful. Figure 1.4 should prove useful when clarification of anatomical terminology is needed.

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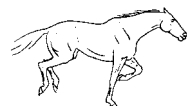
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To all the above and for the encouragement given by fellow ethologists, I give my sincere thanks. My gratitude is also expressed to my wife Ann-Meredith; to my children Sari, Houstoun, and Heidi; to my grandchildren; and to my late parents Houstoun and Irene for their interest in my work, their devotion, and the experiences they have provided.

Southern Illinois University
at Carbondale
September 2001

George H. Waring

Contents



PREFACE	vii
PART I: INTRODUCTION	1
1. Ancestry of the Horse	3
2. Perception and Orientation	18
Vision	18
Hearing	26
Touch, Pressure, and Thermoreception	27
Smell and Taste	28
Proprioception and Equilibrium	32
Pain	33
Orientation and Homing	34
3. Motor Patterns	36
Reflexes	36
Locomotor Activity	38
Gaits	41
Other Motor Patterns	47
Reactive Distances	60
PART II: BEHAVIORAL DEVELOPMENT	63
4. Ontogeny of Behavior Patterns	65
Perinatal Development	65

Post-Natal Development	71
5. Play	83
Solitary Play	84
Play Between Foals and Their Mothers	85
Play Between Foals and Other Young	87
Play Between Young and Adult Horses	89
6. Investigative Behavior	91
7. Learning and Memory	96
Habituation	97
Classical Conditioning	97
Instrumental Conditioning	98
Latent Learning, Insight, and Social Learning	110
Imprinting	111
Memory	113
PART III: MAINTENANCE ACTIVITIES	115
8. Resting and Sleep	117
9. Ingestive Behavior	124
Feeding	125
Food Selection and Preferences	130
Drinking	136
Nursing	139
10. Eliminative Behavior	144
Urination	144
Defecation	147
11. Comfort Behavior	149
Self-Indulgent Behaviors	149
Sunning	149
Shelter-Seeking	149
Licking	150
Nibbling	150

Scratching	152
Rubbing	152
Rolling	153
Shaking and Skin Twitching	153
Tail Switching	157
Mutual Interactions	157
Mutual Grooming	157
Symbiotic Relationships with Birds and Humans	159
PART IV: REPRODUCTIVE BEHAVIOR	161
12. Sexual Behavior of Stallions	163
Patterns of Stallion Behavior	165
Intensity of Sexual Behavior	169
Stimuli Affecting Stallion Sexual Behavior	173
Abnormal Sexual Behavior of Stallions	175
13. Sexual Behavior of Mares	182
Patterns of Mare Behavior	183
Intensity and Duration of Estrus	191
Control of the Estrous Cycle	192
Intrauterine Saline Infusion	193
Photoperiod Manipulation	193
Hormone Injection	194
Other Manipulations	195
Abnormal Sexual Behavior of Mares	196
14. Maternal Behavior	199
Pre-Parturient Behavior	199
Parturient Behavior	201
Post-Parturient Behavior	203
Abnormal Maternal Behavior	208
PART V: SOCIAL BEHAVIOR	209
15. Social Organization	211
Herd Structure	211
Emigration and Immigration	215

Social Roles	217
16. Social Attachment	219
Mare-Foal Attachment	220
Foal-Mare Attachment	224
Peer Attachment	227
Heterosexual Attachment	229
Paternal Attachment	231
Interspecies Attachment	231
17. Home Range and Territoriality	233
Home Range	233
Territoriality	238
18. Social Dominance	243
Establishing and Maintaining Rank	245
Factors Influencing Rank	247
Influence of Rank Order on Daily Activity	250
19. Agonistic Behavior	253
Alert, Alarm, and Flight	253
Aggression	257
Interactions Between Stallions	262
Submission	264
Abnormal Agonistic Behaviors	267
20. Communicative Behavior	270
Visual Expressions	270
Leg and Body Gestures	271
Facial Expressions	273
Tail and Other Gestures	281
Acoustical Expressions	283
Squeal	283
Nicker	284
Whinny (Neigh)	297
Groan	298
Blow	299
Snort	299

Snore	299
Other Sounds	300
Tactile Interactions	300
Chemical Exchanges	301

PART VI: ECOLOGICAL INFLUENCES 303

21. Interaction of Horses and Their Environment	305
Home Range Preferences and Habitat Utilization	305
Bioenergetic Considerations	307
Influence of Resource Distribution on Territoriality	308
Activity Patterns and Movements	308
Environmental Influences on Time-Budgets	308
Diurnal and Nocturnal Movements	309
Seasonal Movement Patterns	309
Antipredator Strategies and the Use of Sanctuaries	310
Symbiotic Relationships	311
Influence of Horses on Their Environment	313

22. Ecological Influences on Reproduction and Social Behavior	315
Factors Influencing Parturition	315
Influences on Development, Sexual Maturity, and Dispersal	316
Factors Influencing Social Structure and Stability	318
Influences on Reproductive Success	320
Behavioral and Ecological Factors in Population Dynamics	323

PART VII: APPLIED ETHOLOGY IN HORSE CARE AND MANAGEMENT 327

23. Behavioral Considerations in Horse Management	329
Enclosures and Housing	329
Social Needs and Human Interaction	332
Exercise and Feeding	333
Grooming and Hoof Care	335
Horse Handling Equipment	336
Transport	336

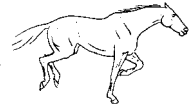
24. Behavioral Manipulation	340
Early Experience and Human Socialization	341
Training	346
Training Environment	346
Fundamentals of Training	347
Restraint	352
25. Behavioral Indicators Relevant to Health and Well-Being	362
Changes in Expression and Posture	362
Changes in Perception and Orientation	364
Changes in Motor Coordination	364
Changes in Maintenance Behavior	365
Changes in Social Behavior	366
Appearance of Problem Behaviors	366
APPENDIX: VARIETY OF EQUINE BEHAVIORAL SYMPTOMS AND POSSIBLE PROBLEMS INDICATED	369
Expressions and Postures	370
Perception Changes	374
Orientation Changes	375
Coordination Changes	375
Maintenance Behavior Changes	379
Social Abnormalities	382
Problem Behaviors (Vices)	383
BIBLIOGRAPHY	385
INDEX	415

Part I



Introduction

1 Ancestry of the Horse



Horses and other equids have not always been the way we see them today. Numerous changes have occurred and many species have existed over the span of millions of years. The foremost center of this diversification was in North America during the Tertiary Period of geologic history (MacFadden 1998). The changes that are recorded in the geological record appear to have been sporadic, probably in response to changing environments and as a result of changing genetic composition. A view of the ancestry of the horse provides us a foundation to understand the behavioral biology of the domestic horse—the subject of this book.

As a member of the family Equidae, the horse is placed with other recent equids into the genus *Equus*. The domestic horse, *Equus caballus* Linnaeus 1758, is the type species for the genus *Equus*. It is one of the several living equid species, which also include the Przewalski's horse, African ass, Asian ass, khur, kiang, and the zebras (Table 1.1).

Among the living equids, the domestic horse is most like the Przewalski's horse. Chromosomal studies reveal many similarities; nevertheless, consistent differences also occur (Ryder et al. 1978; Groves and Ryder 2000; Bowling and Ruvinsky 2000). Domestic horses have a diploid (2n) chromosome number of 64, whereas Przewalski's horses have 66 chromosomes. Although such a disparity may indicate they are each distinct species (Benirschke and Malouf 1967), they could be part of a single species exhibiting chromosomal polymorphism, as occurs in several mammalian species from mice to some large artiodactyls (Epstein 1971) and even the Asian ass (Ryder 1977). Fusing two Przewalski's chromosome pairs together would account for the reduced number of chromosomes in domestic horses (Ryder et al. 1978; Ryder 1994). Crosses of Przewalski's and domestic horses (each having a cytogenetic fundamental number of 92) produce

fertile offspring which have body cells with a diploid chromosome complement of 65 (Short et al. 1974). Blood group and serum protein studies also indicate a similarity between Przewalski's and domestic horses (Podliachouk and Kaminski 1971). Unfortunately, some domestic horse genes may occur in some Przewalski's stock commonly available for research as a result of an early crossbreeding (Dolan 1962).

Przewalski's horses were extinct in the wild by the mid-1900s (Bouman and Bouman 1994); however, the zoo population worldwide expanded exponentially between 1956–1990, reaching 960 by 1990 (Volf 1994). Some of these captive-reared Przewalski's horses have been used to reintroduce the species into Mongolia as a free-ranging population (Bouman et al. 1994).

Table 1.1: Taxonomy of the Horse and Related Species of Living Equids

Listed Sequentially by Diploid Chromosome Number (in parentheses)

Class Mammalia

Order Perissodactyla

Family Equidae

Genus *Equus*

Species and extant subspecies

- (66) *Equus ferus przewalskii* (Przewalski's horse, takh)
 - (64) *Equus caballus* (domestic horse)
 - (62–64) *Equus africanus* (African ass)
 - E. africanus africanus* (Nubian wild ass)
 - E. africanus somaliensis* (Somali wild ass)
 - (62) *Equus asinus* (domestic ass, donkey, burro)
 - (54–56) *Equus hemionus* (Asian ass, onager)
 - E. hemionus hemionus* (Mongolian wild ass, dzigettai)
 - E. hemionus kulan* (Turkmenian wild ass, kulan)
 - E. hemionus onager* (Persian wild ass, ghor-khar)
 - Equus khur* (Indian wild ass, khur)
 - (50–52) *Equus kiang* (kiang)
 - E. kiang kiang* (Western kiang)
 - E. kiang holdereri* (Eastern kiang)
 - E. kiang polyodon* (Southern kiang)
 - (46) *Equus grevyi* (Grevy's zebra)
 - (44) *Equus quagga* (plains zebra)
 - E. quagga burchelli* (Burchell's, Chapman's, or Damara zebra)
 - E. quagga boehmi* (Grant's zebra)
 - E. quagga crawshayi* (Crawshay's zebra)
 - E. quagga zambeziensis* (Upper Zambezi zebra)
 - Equus zebra* (Cape mountain zebra)
 - (32) *Equus hartmannae* (Hartmann's mountain zebra)
-

(cf. Groves 1974; 1994; Wichman et al. 1991; Duncan 1992a; Grubb 1993; Groves and Ryder 2000)

Most equid species are known only from fossil remains. Numerous extinct species and more than 30 genera have been described. Fossil materials from Eocene deposits up to recent times give an excellent overview of equid evolution, especially in North America. It was not orthogonal or straightline evolution, as we sometimes simplify in our mind. For example, when viewed as a whole, there was no constant and overall increase in body size, the legs did not sequentially lengthen, and the feet did not steadily change from four toes to three and finally one. Some lines decreased body size and limb length, while others retained body and limb characteristics relatively unchanged for long periods. Trends varied. Numerous combinations are found in the fossil record. In one genus, for example, certain characteristic changes would be present that would not occur in other evolutionary lines. There were numerous branchings to the family tree and only certain genetic lines survived the rigors of the changing environment over the ages.

When we consider just those ancestral forms that led directly to the present equids, we find that during 60 million years horse evolution went from the dog-like *Hyracotherium*, with four toes on the forelegs and three on the hind, to the genus *Equus*, with a single digit supporting each leg. Simpson (1951) and MacFadden (1992; 1998) have carefully outlined this evolutionary history, the basis of the following summary. The cladogram shown in Figure 1.1 lists the recognized genera and their relationships based on the study of derived characters.

Our review begins early in the Tertiary geologic period, a time in the drift of Earth's tectonic plates where continents were not quite in their present positions. North America was separated from South America but was connected to Europe via Greenland and to Asia in the northwest. The Turgai Straits separated Europe from Asia. There were different species of *Hyracotherium*, and they were widespread in the northern hemisphere where warm hothouse-like conditions prevailed. Judging from tooth characteristics, they all were browsers eating succulent leaves and lesser amounts of soft seeds and small fruits. These animals varied greatly in height from approximately 25 to 50 centimeters (10–20 inches) at the shoulders, and some species were probably eight times heavier than adults of other *Hyracotherium* species. They had arched, flexible backs, and their tails were long and stout. Each of the toes ended in a separate small hoof. The body weight was carried not on the hooves but primarily on a dog-like pad. The lower leg was not vertical in the standing position as we associate with modern equids; Sondaar (1968; 1969) pointed out that the metapodials of early

equids had an obvious slope while in a resting stance (Figure 1.2). The limb construction and the flexible back suggest that changes in locomotor patterns have definitely occurred between these ancient forms and the modern equids. Compared to the possible phenacodontid condylarth ancestors, *Hyracotherium* species showed increased specialization for running (Radinsky 1966).

The Castillo Pocket quarry (south-central Colorado) of early Eocene fossils has provided specimens of two sympatric species of *Hyracotherium*.

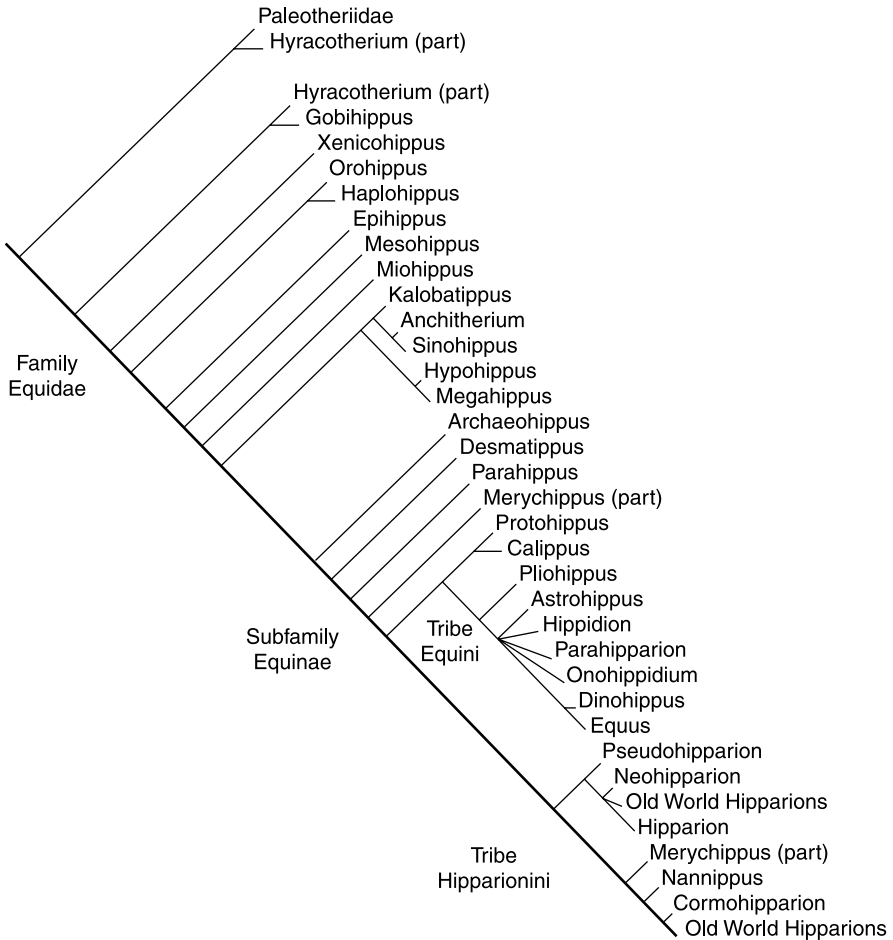


Figure 1.1: Cladogram of the family Equidae, with all recognized genera.
(Adapted from MacFadden 1992)

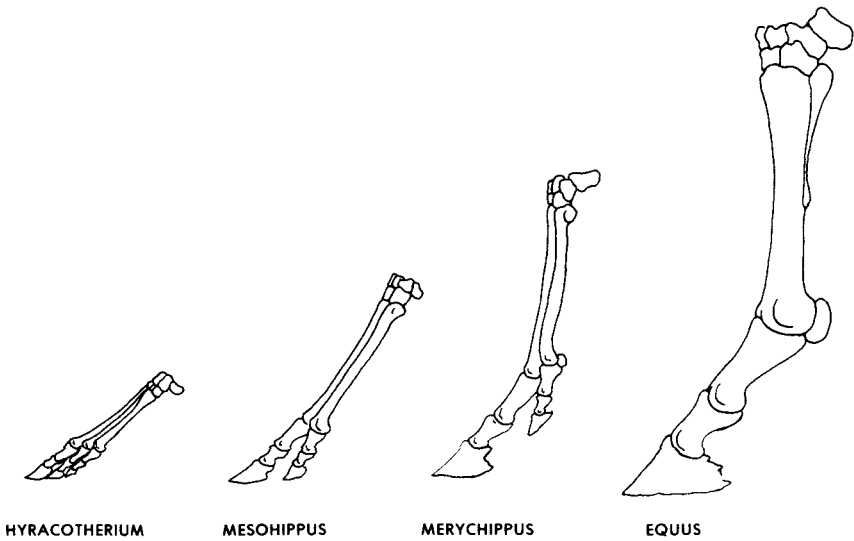


Figure 1.2: Evolution of the equine foot. Side view of forefeet in resting position. Drawn to scale. (Adapted from Simpson 1951 and Sondaar 1969)

The larger species, *H. tapirinum*, was more common; the sex ratio seemed to be one male to 1.5 to 2 females, suggesting males had small harems (based on a sample of 24 individuals). Females were smaller than males. Adult males had canines 40 percent larger than females and likely had to engage in intraspecific competition for mates. These animals occupied an open-park woodland habitat and seemingly fed on herbaceous dicots (MacFadden 1992).

The skull of *Hyracotherium* was only slightly proportional to that of a horse. The brain was small and so primitive that it resembled the most primitive mammal brains. The dentition, consisting of 44 teeth, was beginning to show a trend where the front set of teeth was used for nipping and picking up food and a separate back set was used for crushing and grinding food. The jaw musculature suggested increased specialization for lateral jaw movement typical of herbivores (Radinsky 1966). The horse system of manipulating the food with the tongue was probably also appearing in *Hyracotherium*.

In the early Eocene equids designated as *Hyracotherium*, all the premolars were unlike the molars and the crests on the cheek teeth were not well-developed. Following Middle Eocene, higher latitudes began to cool

and become drier. The land bridge between Greenland and Norway disappeared, as did the Turgai Straits early in the next epoch. Middle Eocene equids, *Orohippus*, and the late Eocene equids, *Epihippus*, retained the low-crowned teeth of *Hyracotherium* but showed progressive development of premolars with molar-like appearance (molarization) and the development of crested or ridged cheek teeth (lophiodonty). These later equids thus had more strictly herbivorous dentition and more effective teeth for browsing.

The genus *Mesohippus* contained the earliest equids known to have had only three toes on the front feet. Such animals probably appeared very much like small horses as they roamed North America in early and middle Oligocene. An equine muzzle was probably present, but proportionally the eye was not yet as far back as in recent horses. The brain case was now swollen, and fossil brain casts show the cerebral hemispheres had become relatively much larger and the surfaces had become convoluted with a series of folds and grooves. The brain was similar in type to a modern ungulate brain. The initial development of the characteristic equine intelligence thus took place during the transition from Eocene to Oligocene and not with the origin of the family. The *Mesohippus* brain was, nevertheless, distinctly more primitive than in later and, thus, more recent equids.

The teeth of *Mesohippus* species were low-crowned and still fitted for browsing, not grazing. The second to fourth premolars were very much like molars in pattern and thus the cheek teeth were a set of crushing and grinding teeth—all similar in appearance.

The legs of *Mesohippus* were long and slender, and the animals had three fully functional toes on each foot with a pad between and behind them to support the main weight of the body. At rest the metacarpals made an angle of about 50° with the horizontal plane (Figure 1.2) unlike later equids whose forelegs became more vertical in the resting position (Sondaar 1969).

In features of the foot and in many other characteristics, the *Miohippus* species of mid and late Oligocene were similar to *Mesohippus*. But with *Miohippus* the metatarsal (cannon bone) of the third or middle toe came into contact with not only the ankle bone, called the ectocuneiform, but also with the cuboid, achieving greater stability in the hock. The three-toed feet of these animals were of advantage in soft soil of forests or along river banks where they likely fed on mature leaves of trees and bushes. The musculature and action of the foot allowed these animals to pull their toes together as the foot was lifted to ease removal of the foot from mud or soft sand.

Miohippus existed into the early Miocene, and there its fossils intergrade with several different descendant groups (see Figure 1.3). Most of these groups diversified further as three-toed browsers. Some emigrated from North America to the Old World (where the various paleothere descendants of primitive *Hyracotherium* species had long become extinct). This line of browsers (e.g., *Kalobatippus*, *Anchitherium*, *Sinohippus*, and *Hypohippus*) became extinct by late Miocene.

One line of development from *Miohippus* did continue successfully, in North America. Some of these equids were beginning to eat grass, and their teeth and digestive system continued to change to enable them to utilize the abrasive, high fiberous foods. Grasses were becoming common in the cooling and drying environment, replacing tropical and moist warm-temperate flora. Compared to a diet of browse, grasses had far more abrasive silica bodies in the leaf structure. Nevertheless, these equids exploited to varying degrees this new resource; thus a wave of explosive adaptive radiation occurred, beginning about 20 million years ago. The excellent fossil record shows gradual changes from *Parahippus* of early Miocene to the mid and late Miocene descendants placed by paleontologists into the paraphyletic genus *Merychippus*. *Parahippus leonensis* had a potential longevity of approximately nine years compared to four years for *Hyracotherium*.

Among the tooth pattern changes were an increase in the complexity of the grinding surface, deposition of a bone-like substance called cement outside of the enamel, and an increase in the crown height of the teeth (hypsodonty). The net result of these modifications was cheek dentition increasingly adapted for grinding by motion of the lower jaw from side to side against the upper jaw, for teeth that would remain free of deep pits as the tooth wore down, and for teeth that would endure years of grinding wear. These equids became increasingly adapted to select and contend with the highest fiber, lowest protein diet in the grazing community by perfecting cecal (not ruminant) digestion, in conjunction with increased rate of intake and passage (Janis 1976). But variation did exist. For example, studying carbon isotopic and tooth microwear, MacFadden et al. (1999) compared six sympatric species of late Miocene equids of Florida. All six species had high-crowned teeth and traditionally would have been considered grazers. The researchers concluded that not all species were grazers on grasses (i.e., using the C_4 photosynthetic pathway); some species were mixed feeders, and some fed primarily on browse (i.e., C_3 pathway).

Although less rapidly than in the teeth, other morphological changes were also occurring in the Miocene. The skull was becoming more

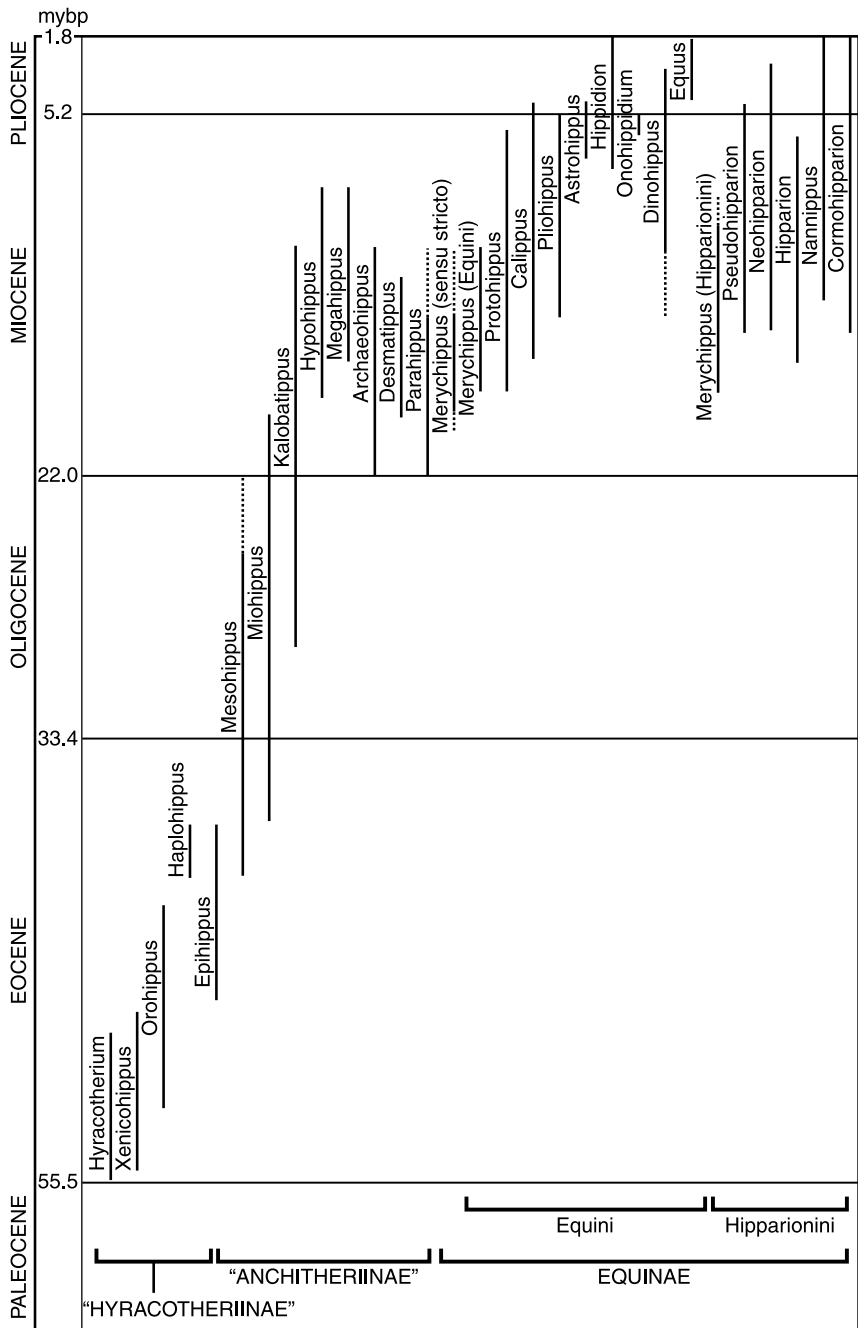


Figure 1.3: Temporal overview of North American equid genera of the Tertiary.
(Adapted from MacFadden 1998).

Equus-like, as was the brain. The eye appeared more posterior in the head because the muzzle was more elongated than before (Radinsky 1983). The body and leg proportions differed between species; some were strong and stocky, others were slender and fleet in appearance. In adult *Merychippus*, the ulna had fused with the radius in the forelimb and was no longer movable as a separate unit. In the hindleg, the fibula had lost much of its shaft and was reduced to a spike-like bone (splint) as seen in modern horses (see Figure 1.4). Such changes further limited rotation of the limb extremities. The limbs were specialized for locomotion with spring-like action, moving only in a fore-and-aft plane. The extremities did not retain maneuverability for holding or manipulating objects; yet fetlock flexibility was greater (Sondaar 1968). In the most advanced forms, the side toes were short and the primitive footpad of their ancestors had been lost. The weight was carried on the central toe which was tipped with a large convex hoof.

Merychippus diversified into a number of descendant varieties. Body size, side-toe length, and tooth pattern varied between species. Grazing seemed to be the predominant form of feeding. Recent investigators have separated the merychippine complex into two monophyletic clades, namely the tribes Equini and Hipparionini (Figures 1.1 and 1.3). In the latter, a portion emigrated from North America to the Old World. The major North American taxa in the tribe Hipparionini include *Pseudhipparion*, *Neohipparion*, *Hipparion*, *Nannippus*, and *Cormohipparion*. Equini include a portion of the *Merychippus*, plus *Protohippus*, *Calippus*, *Pliohippus*, *Astrohippus*, *Hippidion*, *Onohippidium*, *Dinohippus*, and *Equus*. Detailed study of *Protohippus* fossils has revealed the potential longevity was 12–15 years, which is longer than reported for *Merychippus* but less than *Equus* (i.e., greater than 20 years in natural populations). Social tendencies and seasonal reproduction were probably widespread.

There is consensus that the closest relative of *Equus* is within the Equini (the clade united by at least six shared-derived character states, including dorsal preorbital fossa, dentition, and limb characteristics), but there is less agreement on the exact ancestral line for *Equus*. A unique feature not found in modern equids was the tendency for the skull of *Pliohippus* species to have deep pockets in the skull surface anterior and below the eye sockets. These facial depressions apparently served as sites for the attachment of snout and lip muscles. Because of the complex facial depressions in *Pliohippus* (and basic absence in *Equus*), MacFadden (1998) has argued the *Equus* ancestral line was not that of *Pliohippus*.

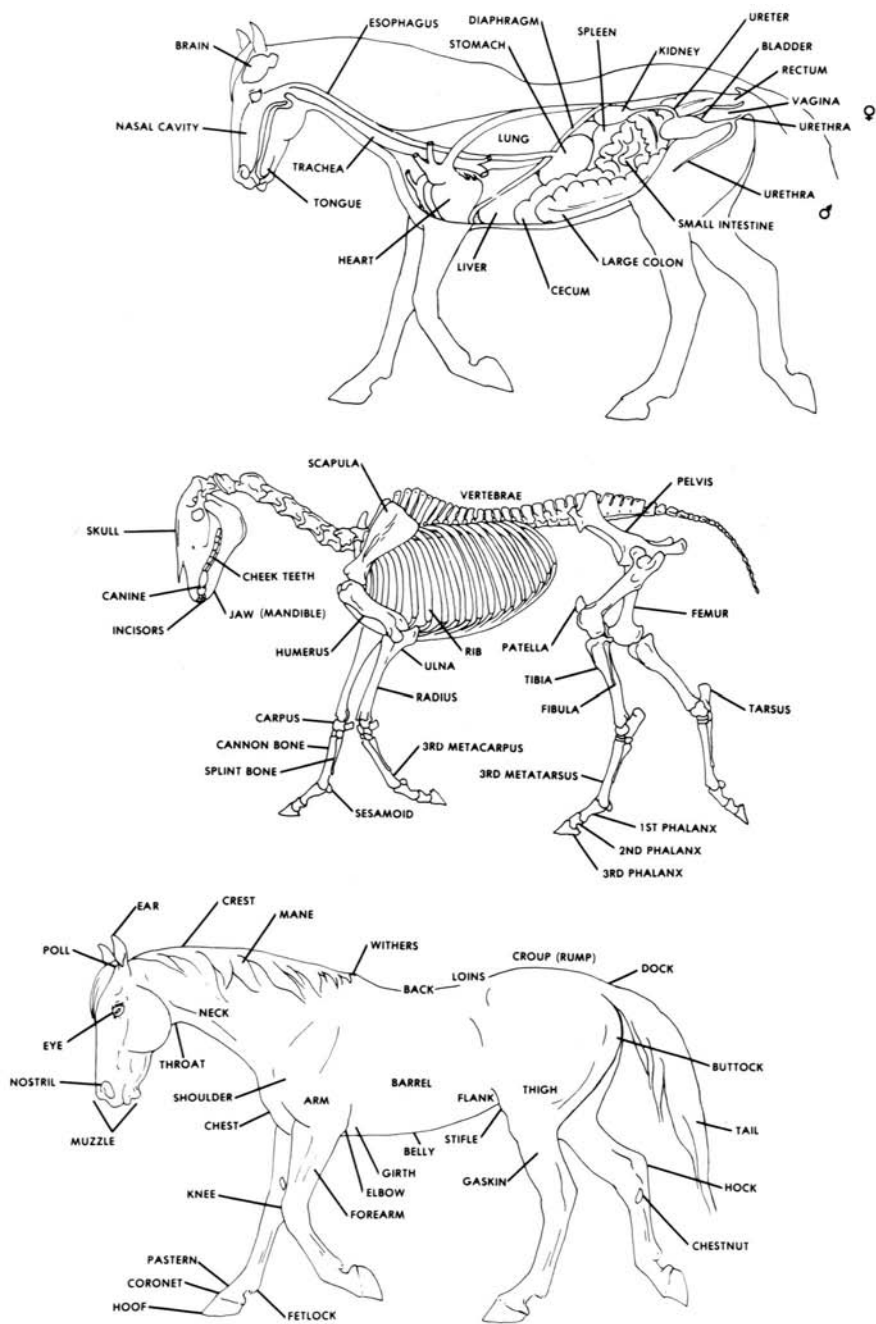


Figure 1.4: Internal and external morphological characteristics of the horse.

Dinohippus, with poorly developed facial fossae and certain derived dental characters, is now considered the sister taxon of *Equus*; *Dinohippus* was common in late Miocene through early Pliocene. In the Pliocene, soon after the Panama land bridge formed, some equids dispersed to South America from North America.

Primitive taxa within the Equini were tridactyl (three toed), whereas advanced forms of *Pliohippus*, *Astrohippus*, and *Dinohippus* were monodactyl (single toed). In the monodactyl forms, only internal vestiges of the side toes remained, these were long splint bones along each side of the cannon bone. Thus in the Miocene epoch some equids were one toed. They were capable of swift, prolonged running. Based on mitochondrial DNA analyses, data suggest that the common ancestor of extant *Equus* species was living approximately 3.9 million years ago and that speciation leading to the lineages of surviving members occurred over the next half million years (George and Ryder 1986).

Fossil representatives of the genus *Equus* were very widespread during the Pliocene until the late Pleistocene in North America. Although numerous species are described from fossil material, the forms are perhaps synonymous with *E. simplicidens*, *E. scotti*, *E. francisi*, *E. alaskae*, and *E. laurentius*. As time progressed, there was further lengthening of the cheek teeth which became straighter and somewhat more complicated in structural details. Soon after the early forms appeared in North America and while still in the more primitive stage, *Equus* dispersed to the Old World via the Bering land bridge. The spread of *Equus* to South America over the Panama land bridge soon followed. Thus, within a period of 1 to 1.5 million years, *Equus* had dispersed into every continental and biogeographic region, with the exception of Antarctica and Australia.

In the approximately 4 million years since their first appearance, members of the genus *Equus* have emigrated in many different directions and at different times. Each of the many species have had their distinct form and, no doubt, distinct habits. Throughout much of North and South America, Europe, Asia, and Africa, fossils of *Equus* occur widespread and abundant in Pleistocene deposits. In both of the Americas, wild horses survived the Ice Age and were still common when the first Indians arrived, but then the herds on both American continents completely disappeared about 10,000 years ago—perhaps, directly or indirectly, as a result of human hunting pressure. Thus, the western hemisphere was without equids for several thousand years until the domestic horse (*E. caballus*) was first brought to the Americas by Spanish explorers in the sixteenth century.

In Asia, Europe, and Africa, *Equus* species survived and diversified. But in recent centuries, the range of most surviving wild species has greatly diminished. A definitive representation of the recent progression of horse evolution utilizing only the fossil record is tenuous. Molecular techniques are providing some clues, for example, that speciation followed three lineages—zebras, asses, and caballine horses (George and Ryder 1986).

In late Pleistocene, prior to the beginning of domestication, long-term isolation of equid populations undoubtedly occurred, which led to what is now distinct species. The caballine horses inhabited Eurasian lowlands north of the great mountain ranges. The hemiones, khur, and kiangs occupied the arid zones of Asia from the Gobi to Syria and into northwest India. The ass ranged primarily along the northern zone of Africa (Zeuner 1963). While each species continued to evolve characteristics independent of the others, they also differentiated into geographical races or subspecies which are now more or less distinct (see Table 1.1). These geographical races are apparent in the hemiones and kiangs where several extant subspecies are recognized. The mountain zebra occurs as two species; the plains zebra, as several contemporary subspecies; and the African ass, as two races in the wild condition. The surviving caballine horses are now reduced to two kinds—the domestic horse and the Przewalski's horse.

Some authors have suggested that domestic horses were derived from more than one wild type. Their aim has been to explain differences in conformation of the animals depicted in ancient cave paintings, engravings, and sculptures as well as differences noted among contemporary and ancient horses, such as in body size, temperament, and other characteristics. For example, Speed and Etherington (1952a; 1952b; 1953) Ebhardt (1954; 1957; 1962), and Skorkowski (1956; 1971) have furthered the concept of a multiple origin of the domestic horse from several discrete primitive types present in the Pleistocene. Chronological gaps, cytogenetic issues, and alternative explanations based on selective breeding have often been slighted in such essays.

But the multiple origin of domestic horses has not become a fulsome idea. The extensive analysis of mitochondrial DNA (mtDNA) of both modern and ancient horses by Vilà et al. (2001) has shown that modern horses have almost as much genetic variation as did the fossil horses examined. This eliminates the possibility horses were domesticated in just one place and spread from there. If horses had been domesticated once from a limited number of ancestors, the mtDNA of all modern domesticated horses should look basically similar. The high diversity of matrilineal lines observed among modern horses implies wild horses from a large number

of populations were founders of the domestic horse. The concept and techniques for horse utilization may have occurred at one location, but soon the technology (but not the specific animals) became widespread. The technology for horse capture, taming, and rearing was applied by each culture on wild horses of their geographic area. Captive breeding eventually followed. Thus, the domestic horse population of today is a result of the interbreeding of many lines of wild horses from multiple places.

Evidence that is available from Paleolithic times to the present suggests that horses of quite possibly different types were widely scattered along the arid and the fertile steppes, forests, and tundra of Eurasia. These herds probably belonged to a single species (e.g., see Nobis 1971) and could potentially interbreed yet were remaining reproductively isolated until influenced by human activities. To account for the apparent scattered and intermingled distribution often noted in these horse types, Zeuner (1963) suggested that these populations perhaps were not strictly geographical subspecies per se, occupying different land masses, but may have been ecotypes, preferring different habitats. Thus each variety would tend to occupy its preferred habitat type (i.e., grassland, loess-steppe, tundra, or forest) wherever the herds existed across Eurasia.

Apart from geographical or ecological reproductive isolation, social behavior may also have separated populations and caused discrete population characteristics to develop and be maintained. For example, prolific harem stallions showing a preference for mares of one color could increase the frequency of genes with that characteristic in subsequent generations. Linkage and pleiotropism could carry along additional genetic characteristics. Feist (1971) noted that feral horses he observed showed evidence of distinct color preferences. Some stallions had only buckskin mares in their social units; others had no buckskin mares but emphasized sorrel or bay. If descendants of those bands maintained similar preferences (e.g., through learning) and had higher than average reproductive success, the herd subsequently might emphasize one set of characteristics; other herds may have emphasized different traits. Such differences would be similar to those observed in paleontological and archaeological records of Eurasia where varieties were not geographically isolated in a distinct way or by good physiological barriers. Social preferences, social attachment, and other behavioral traits of herd members could create a montage of different population characteristics throughout the distribution of the species.

Reproductive isolation by whatever means would account for some progression of distinct genotypic and phenotypic characteristics. The varieties

surviving glaciation and present at the dawn of horse domestication were according to Zeuner (1963) and Heptner et al. (1966): (a) Przewalski's horse, (b) tarpan, and (c) forest horse. Groves (1974) designated them *Equus ferus przewalskii*, *E. f. ferus*, and *E. f. silvestris*, respectively.

In reviewing and summarizing the domestication of the horse, Epstein (1971) concluded that pastoral tribes of the Mongolian steppes and plateau probably did not first domesticate the horse, but that domestication perhaps first occurred in the early third millennium B.C. by a settled agricultural population in the western part of the grassland zone of the European Plain, such as the Tripolye culture in the valleys north of the Black Sea. Wild horses did not occur in southern and Mediterranean regions, but horse herds were available to the Tripolye and the Caucasus cultures. These horses are thought to have possessed coarse features, more characteristic of the Przewalski's horse than any other variety (Epstein 1971; Brentjes 1972). Clutton-Brock (1992; 1999) concluded that these horses were not Przewalski's horse but from a wild stock that inhabited the plains of southern Russia—from the Ukraine to the region of Turkestan.

Heptner et al. (1966) suggested the zone between Przewalski's horses to the northeast and tarpans to the west was perhaps the Volga River. If so, the horses in the vicinity of the Tripolye settlements would have been tarpans. Furthermore, the range of the forest horse was north and westward of the Pinsk Marshes north of Kiev, quite accessible to the Tripolye settlements nearby. Thus the controversy as to which horse type was initially utilized in domestication remains complicated and unresolved.

Equids had long been used as food by humans and herds diminished as a result, but subsequent to 4300 B.C. something more appeared to be occurring. In archaeological deposits of this period at Dereivka in the Ukraine (Anthony et al. 1991) and at Botai in northern Kazakhstan (Levine 1999) horse remains became noticeably more common. The majority of the horses were killed by stalking or chasing at Dereivka and by driving or surrounding at Botai. But the studies at Dereivka on the west bank of the Dnieper River 250 km south of Kiev by Anthony et al. (1991) have found the relationship between horse and rider may have originated in that Copper Age society 6,000 years ago. Ecologically the site was between the forest steppe to the north and the true steppe to the south. At Dereivka, evidence for the increased use of horsemeat suggests that the Sredni Stog culture either had extraordinary access to free-ranging wild herds or domesticated and raised the animals as a source of food. And, perhaps they rode some of the horses.

Among the artifacts of the site were perforated pieces of antler that appear to be cheekpieces of a bit. More importantly, there was also a skull of a stallion, 7 or 8 years old, whose lower premolars showed wear damage that, for a variety of reasons, seemed to be caused by a bit (Anthony and Brown 1991). According to Anthony et al. (1991), dispersal of horse domestication technology (including riding) was first eastward, then westward (between 3500 and 3000 B.C.), and finally southward. When horses finally appeared in the Middle East about 2200 to 2000 B.C. they were promptly used in a role formerly played by ass and ass-onager hybrids—as draft animals attached to battle carts. Size and speed made the horse superior.

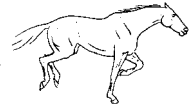
Knowledge of horse domestication and use, once begun, spread rapidly through Asia and Europe, especially with the introduction in the early second millennium B.C. of the lighter weight horse-drawn war chariot with spoked wheels. Selective breeding was concurrent with the spread and diversification of horse utilization and included crossbreeding with ass and onager (Brentjes 1969; 1972; cf. Clutton-Brock 1992).

Eventually wild varieties, with the exception of small remnant herds in inaccessible or barren environments, were absorbed into the domestic stock (Epstein 1971). Moreover, in time, wild and feral herds were systematically reduced or eliminated because of their depredation on agricultural crops and attempted covetry of domestic mares.

The traits emphasized in the domestic herds varied between cultures and as needs arose, such as mounts for heavily armored riders. Selective breeding occurred. This resulted in variation of size, facial appearances, color, temperament, and other characteristics noted in ancient as well as more recent domestic horses. Variation, its utility, and its historical basis provide us much to contemplate (e.g., see Pruski 1963; Schäfer 1971; Kaminski and Duncan 1981).

The domestic horses of today may only partially resemble their wild ancestors in conformation and coloration; yet many traits are shared. Basic behavioral and physiological traits may have been little altered by domestication; domestic horses can still readily adapt to a wild existence. Feral herds show survival traits typical of species that have never been domesticated. Management practices may suppress certain behavioral tendencies, but the potential remains. In subsequent chapters, behavioral traits of horses under free-roaming conditions will be emphasized as the characteristics of the species.

2 Perception and Orientation



Horses are well known for their keen sensory perception. They are alert to changes in their environment and have utilized their adept perception to facilitate survival. Sensory perception is the way a horse monitors its environment, its own situation, and changes that take place. This certainly involves the eyes, ears, and nose. Yet perception also involves other sensory receptors, such as those along the surface of the body and others hidden from view. In addition, sensory perception helps an individual maintain a stable posture, move successfully, orient properly, conduct daily activities, travel, avoid hazards, and return to worthwhile resources.

Vision

Undoubtedly, the most important receptor system of horses is the visual system.

To begin to understand this sensory system, it is necessary to put equine vision in a proper ecological, morphological, and physiological context. Thus, first consider the horse's need for vision. Horses, as were their recent ancestors, are basically open range animals with little threat from aerial predators. Their predators have been ground dwelling forms—as are their social companions and their nutritional sources. Thus, it should not surprise us to find the equine visual system is tuned not only to a wide panorama of the horizon but also toward the front of the animal where it must place its feet, obtain nutrition, and avoid ambush as it travels. Its visual realm is not skyward but groundward. In their natural habitat, it is beneficial for horses to see in bright light as well as in the nocturnal period.

The eyes of horses are in a lateral position relatively far back on the skull. Each eye is rotated and moved synchronously with the other by the

interaction of seven muscles attached to the eyeball. In addition, the eyes can be elevated, turned, and tilted by supplementary movements of the head and neck. At rest, the optic axis of each eye diverges about 40° from the anterior midline (longitudinal axis of the body) and about 20° below the horizontal (Hughes 1977).

The morphology of the equine eye is unusual not only in size but also in shape (Figure 2.1a). The horse has one of the largest eyes of any living animal. The retina is asymmetrical with a tendency for the retina to be closer to the lens especially, but not exclusively, below the optic axis (Nicolas 1930; Sivak and Allen 1975). In 1818, Soemmerring first illustrated this asymmetry phenomenon and noted the distance between the cornea and the retina of horses (38 mm) surpassed most other animals. Besides this large internal space, he observed the circumference of the horse retina was even greater than in the eye of the far larger bowhead whale (Andersen and Munk 1971).

The expansive retina of the horse allows for an extreme range of peripheral vision. Yet the perceptual field of view is in need of modern-day testing and verification. Reportedly each eye has a horizontal visual field of up to 215° (average 190° – 195°). An overlap of the visual field of each eye occurs, giving the horse a 60° – 70° binocular field of view anteriorly (Duke-Elder 1958). This binocular field of view is extended downward along the midsagittal plane (Figure 2.1b), enabling the horse to view the ground in front with both eyes (Figure 2.2). The horse can re-orient the binocular view as needed by elevating, turning, and extending the head. The retinal field of view of each eye in the vertical plane is 178° (Hughes 1977). A blind zone (illustrated in Figure 2.1b) begins in front of the forehead and continues posteriorly; Harman et al. (1999) underscored that a horse ridden “on the bit” with head flexed and facial surface nearly vertical leaves the horse with a blind frontal field. In the posterior direction from each eye, the visual field almost parallels the body axis leaving a narrow blind zone behind the animal (Figure 2.1c). Of course, a slight turn of the head or neck enables the horse to scan even this area behind its body. In strong light the vertical diameter of the pupil narrows, accentuated by the corpus nigrum (Figure 2.1a), forming an oblong, horizontal pupil opening which reduces light yet maintains the visual field in the horizontal plane.

Histological examination shows the retina to be complex consisting of numerous microscopic layers (e.g., see Wouters and De Moor 1979). Among the neural elements are rod and cone receptor cells plus ganglion cells. Although the equine retina lacks morphologically a macula and its pit-like fovea, it does have one and perhaps two regions of acute perception.

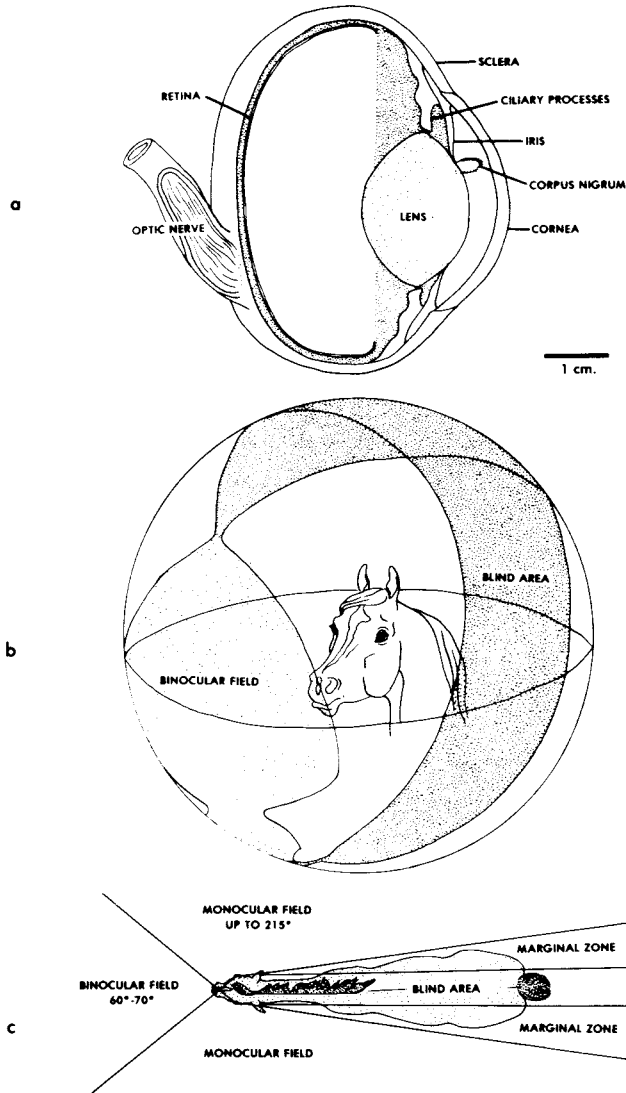


Figure 2.1: Vision in horses: (a) the asymmetrical eye (after Soemmerring 1818), (b) ophthalmoscopically defined ocular field (based on Pisa 1939 and Hughes 1977), and (c) panoramic visual field. (Adapted from Waring et al. 1975)

The less-confirmed region is called the area centralis (or area retinae)—an optically acute area 2 to 5 mm in diameter comparable to the sensitive macula lutea in humans. It is reported to be about 15 mm dorsal and

slightly lateral to the site where the optic nerve merges with the retina (Prince et al. 1960; Prince 1970). Hebel's (1976) detailed study of the retina was not able to confirm the existence of the area centralis. The well-known area of increased cell density is a band-like area called the visual streak which extends horizontally across the retina. It lies dorsolateral to the optic disc and medial to the area centralis (Prince et al. 1960; Hughes 1977).

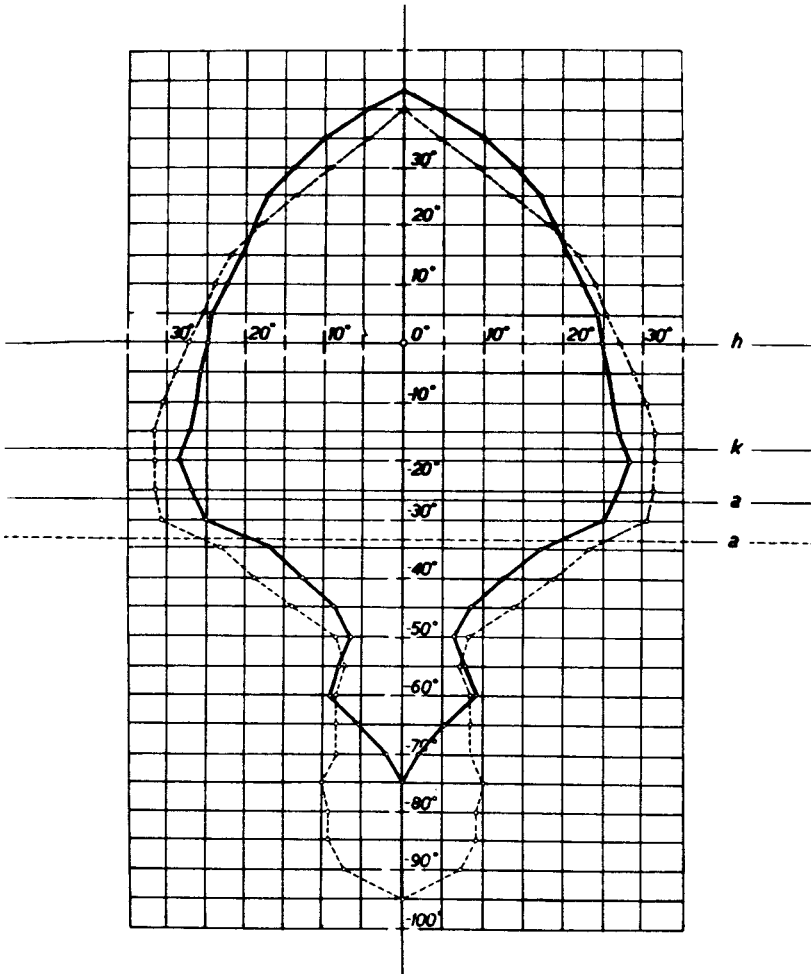


Figure 2.2: Projection of the binocular visual field of an adult horse (solid line) and a foal (broken line). Maximum width of the binocular field coincides with plane (k) formed by the corners of each eye. Plane of optic axis = a; horizontal plane = h. (From Pisa 1939)

In both the visual streak and the area centralis, there are a higher proportion of cones to rods, although a duplex retina is maintained. The area centralis is thought to function especially in forward binocular vision, whereas the visual streak apparently broadens horizontally the acute field of view.

To ascertain the shape and location of the regions of acute vision, Hebel (1976) studied the distribution of ganglion cells of the horse retina. He found a well-demarcated 1 mm linear band of high cell density located about 3 mm dorsal to the optic disc and extending about 22 mm in both the nasal and temporal direction. Ganglion cell density of more than 6,500 cells/mm² occurred in the temporal arm of the visual streak. In the nasal arm the density was relatively high (3,000–4,000 cells/mm²) but less distinct. For several millimeters on either side of the visual streak the ganglion cell densities were between 500–3,000 cells/mm² then diminished to less than 500 cells/mm² over the remainder of the retina. Harman et al. (1999) found similar results and that the retina is equidistant from the lens except in the far dorsal and far ventral retinal areas, where the lens is closer to the retina.

Although daylight vision is the most keen for fine detail, nocturnal vision in horses is superior to that of man. Rods are especially involved in night vision. Hughes (1977) calculated (based on maximum pupil diameter) that the horse, owl, dog, and gray squirrel have similar light collecting power in spite of the difference in the size of their eyes; they rank below the cat, rabbit, rat, and bat. Except for the area centralis and visual streak, rods are in higher proportion than cones in the horse retina; thus, throughout much of the retina, cones account for only 5–10 percent of the receptor cells (François et al. 1980). Similar to many nocturnal animals, the horse has an eye with a developed tapetum lucidum—a fibro-elastic tissue zone of the choroid having a metallic luster which reflects light back through the retina and causes eyeshine when the eyes are illuminated at night.

The type of accommodation or focusing mechanism occurring in horses has been the subject of controversy and needs further study. The debate is whether it is static or dynamic accommodation, or both. Based on the asymmetrical retina (usually considered skewed with greater distances occurring in the dorsal direction), some authors (e.g., see Walls 1942) conclude that static accommodation system is operating, where nearby images and distant images simultaneously focus on different parts of the so called “ramp retina.” Other authors (e.g., see Harman et al. 1999) suggest otherwise.

The existence of the area centralis and associated visual streak (sites of acute vision) seems to contradict the concept of a functional ramp retina; yet, such sensitive sites are consistent with dynamic accommodation.

Moreover, Sivak and Allen (1975) could find no indication of a ramp retina that could serve static accommodation and, in fact, observed some dynamic accommodation ability in living horses. Prince et al. (1960) suggested that a small degree of dynamic (ciliary) accommodation could exist together with the ramp retina in the horse. Generally, the horses examined by Harman et al. (1999) were emmetropic (correctly focussed), with a slight tendency to be hyperopic (long sighted).

The equine lens is elastic—a necessity in dynamic (lens-adjusted) accommodation. Thus, Sisson and Grossman (1953) proposed that to accommodate for near objects the ciliary muscle contracts and pulls the ciliary processes and associated ciliary ring forward (see Figure 2.1a) releasing tension on the lens and thus slackening the ciliary zone, allowing the lens to become more convex. Motion of the midpoint of the lens forward (axial translation) plays some role in accommodation of some species; however, this mechanism, though feasible, has yet to be demonstrated in horses (cf. Hughes 1977). In old age, the lens tends to become less elastic and may lose its transparency.

With a series of two-choice discrimination tasks, Timney and Keil (1992) studied visual acuity in three horses utilizing 20 x 25 cm high-contrast square-wave gratings with periods ranging from 1.3 mm to 30.0 mm. Conservatively, the best acuity obtained was 23.3 cycles/degree. They concluded the resolution acuity of horses is limited by ganglion cell density in the temporal portion of the visual streak.

In a subsequent study, involving relative-line-length discrimination, Timney and Keil (1996) began to assess monocular and binocular depth perception of horses. They found horses could reliably distinguish (at a viewing distance of 160 cm) a lower line of 10 cm from an upper one of 14 cm. Subsequently, when allowed to choose between different photographs, the horses overwhelmingly chose the display containing converging railway tracks. To humans, the converging tracks create a Ponzo illusion, making the upper line appear longer. The investigators concluded the horses, too, were susceptible to a Ponzo illusion created by depth cues in the photographs. They (Timney and Keil 1999) went on to investigate whether horses utilize monocular or binocular cues to judge depth perception. Using random-dot stereograms where the view of test surfaces is restricted to one eye, the investigators concluded horses have true stereopsis and can recognize small differences in the relative distances between two stimuli.

As a result of the optical and morphological properties of the equine eye, motion along the edge of the field of vision may be accentuated (Simpson 1951; Knill et al. 1977). Undoubtedly, some ganglion cells of the retina are

specialized to help detect peripheral motion, such as may be made by a predator. A horse is often startled and overreacts to the apparent sudden motion occurring on the ground at the margin of its visual field while standing or as motionless objects momentarily appear in and out of the visual field while the horse itself is moving. These visual startle responses were likely of survival benefit to wild ancestors who were vulnerable to predators. Sudden flight was the best defense.

The debate continues over the extent of color vision in the horse (e.g., see Wouters et al. 1980). In general, investigators are finding color perception is far more widespread among mammals than formerly realized. The horse retina does have both rod and cone receptors (Wouters and De Moor 1979), but the complete characterization of these receptors and their interaction with other cells of the retina need elucidation. Unlike rods, cones operate efficiently at higher light levels, and for the non-primate mammals two types of spectrally-distinct photopigments typically occur among the cone receptors (one with maximal absorption about 440 nm and a second with maximum absorption closer to 550 nm). Color detection and discrimination involve the cones, their interaction with the rods, and the nervous system's comparisons of the outputs of these receptors (Jacobs 1993).

Grzimek (1952) investigated color vision in two mares, four and six years of age. He concluded his subjects could see color and not merely different shades of gray. In a series of discrimination trials contrasted with 27 shades of gray, the yellow test colors were identified most easily, green colors were second, then the blues, and finally the red colors. Light red was selected more easily than more absolute red choices; yet, saturated blue choices were correctly chosen more easily than lighter blue. At a distance of 3.3m, a 0.5 cm perpendicular yellow line was reliably detected (a visual angle of as little as 3'15"); whereas at the same distance, a blue streak of a minimum of 2 cm was reliably detected (angle of 20'41"). Thus the acuteness of vision of the horse appears to be slightly less than that of humans; our eyes also are limited in blue visual acuity.

Using a two-choice discrimination apparatus with painted cards in a double-blind procedure, Pick et al. (1994) attempted unsuccessfully to fully replicate the Grzimek (1952) study using a 19-year-old mare as the subject. Three levels of blue (462 nm), green (496 nm), and red (700 nm) paint were mixed to match the reflectance level of three of five gray cards used as stimuli. The mare was able to reliably discriminate blue vs. gray and red vs. gray without regard to reflectance; however, the mare did not

discriminate successfully green vs. gray. Smith and Goldman (1999) tested five horses (age 3–20 years) with more success using a two-choice color vs. gray discrimination procedure with illuminated translucent panels. Their results indicated horses can discriminate the colors blue (470 nm), green (538 nm), yellow (581 nm), and red (617 nm) from various shades of gray. One of the subjects (a 15-year-old gelding) was unable to learn the green vs. gray discrimination (similar to the Pick et al. mare above) as well as the yellow vs. gray discrimination, but quickly learned the other color discriminations. Since prior studies had not controlled for luminance, Macuda and Timney (1999) conducted a two-choice discrimination on two horses and included luminance as part of their investigation. For red and blue targets, the performance of the horses was high irrespective of luminance; however, for yellow and green targets, performance decreased near the achromatic luminance match. The conclusion is that horses can discriminate colors, such as blue and red; however, color discrimination is weak in the yellow-green region of the color spectrum.

Besides color detection, horses show good visual pattern discrimination. They can learn to recognize correct choices in 20 or more two-choice discrimination sets, such as triangles verses dots of the same size (Dixon 1966). In the recognition of human beings, horses rely on facial characteristics as well as clothing (Grzimek 1944b). Anecdotal literature reports that some Arabian horses have been known to visually identify their master from similarly dressed men at a distance of 0.4 km (0.25 mile) or more.

Consistent with their discrimination abilities and being social animals, horses respond to horse-like objects differently than they do to other test objects. Grzimek (1943a) found two- and three-dimensional horse imitations were approached and investigated like conspecifics, for example, at the nose and flanks; but incomplete drawings and dog pictures were not investigated in such a manner. Vision is used for individual recognition between horses along with odors and vocal characteristics (cf. Wolski et al. 1980).

Additional indications of the visual acuity of horses are the fascinating stories of such horses as Kluge Hans (Pfungst 1907), Lady (Rhine and Rhine 1929a,b), Muhamed, and Mahomet (Christopher 1970). These horses amazed observers by answering mathematical, spelling, and other questions with head movements and leg gestures. Yet in each case, it was eventually discovered that the horses could only perform accurately if someone was present who knew the answer and signaled the solution by a slight gesture to the keenly observant horse.

Hearing

Horses have been reported to respond to geophysical cues (possibly the relatively low-frequency seismic P waves) that precede the shaking of earthquakes. Whether this response involves the ear is unknown. Nevertheless, moments before the ground starts to shake during an earthquake, horses often show nervousness and vocalize (e.g., see Lawson 1908; Penick 1976; Kirschvink 2000). As for high frequency sounds, horses perceive frequencies above the human perception range.

Ödberg (1978) in a test of equine hearing, observed distinct ear reactions (Pryer reflexes) to pure tones at frequencies up to 25 kHz. At the highest frequencies, older horses (age 15–18) showed less response than subjects of 5–9 years of age. Further studies have found the horse cochlea consists of 2.5 spiral turns, with audible frequency range of 0.20–22 kHz (6.8 octaves) at 30 dB SPL and 0.055–33.5 kHz (9.3 octaves) at 60 dB SPL (Heffner and Heffner 1983; West 1985; Echterler et al. 1994). It appears that horses are able to detect a broader range of sound vibrations than can humans, especially in the upper frequencies; nevertheless, the bulk of the sound energy perceived by horses is within the frequency and amplitude range audible to human ears. The region of best sensitivity in the horse is from 1 to 16 kHz, with lowest threshold of 7 dB (Heffner and Heffner 1983).

It becomes readily apparent to an observer that horses rotate their ears (pinnae) in response to directional sounds. The independently movable pinnae enable acoustical orientation toward sound sources without the necessity of changes in head or body position. A complex of muscles innervated by branches of the facial as well as first and second cervical nerves induces the action of the ears. When the ears are vertical and drawn forward, the opening is directed forward. The opening also can be rotated to focus to the side or posteriorly; whereas, when the ears are fully laid back, the opening is toward the ground and semi-closed by compression.

Sound localization was once assumed to be more accurate for large mammals than small mammals because interaural distance would seemingly generate large binaural localization cues both in the time of arrival (Δt) and the frequency-intensity spectrum (Δf_i) of a sound reaching the two ears. However, after a study of horses, Heffner and Heffner (1984) concluded that sound-localization acuity is not determined simply by the physical availability of binaural cues. They measured interaural time difference (Δt) of horses and found that Δt was 501 μs when the loudspeaker was 90° from the animal's midline. At angles 0–90° from midline, the Δt of the horse exceeded those published for the domestic cat. But compared to human data,

the horse had the larger Δt at angles below 35° , whereas the human Δt exceeded the horse Δt at larger angles—head shape seemingly caused the shift. Nevertheless, the horse was found to have a comparatively large Δt cue available to it. And the available Δf_i cue appeared large enough to support accurate localization (at least in other mammals); however, the investigators found the sound direction thresholds of the horses they tested were markedly poorer (i.e., mean of 22° for noise and 30° for clicks) than those of other large mammals. Thus, Heffner and Heffner (1984) surmised the horse apparently has not developed the neural capacity to take full advantage of the binaural cues available to it.

In a subsequent sound-localization study, Heffner and Heffner (1986) required horses to discriminate the locus of a single tone pip ranging in frequency from 250 Hz to 25 kHz emitted by loudspeakers located 30° to the left and right of the animal's midline. All five test animals were able to localize 250 Hz, 500 Hz, and 1 kHz pips but were unable to localize test stimuli of 2 kHz and above, suggesting that horses can use the binaural phase-difference cues but are unable to use binaural intensity differences. The investigators (Heffner and Heffner 1992; Heffner 1997) subsequently examined the relatively poor sound localization ability of horses and made comparisons to various visual factors (e.g., visual acuity, width of binocular field, and width of maximal visual field). The strongest correlation was between the width of best visual field and sound localization. Thus, for horses, accurate sound localization is not essential to orient the head and eyes before visually inspecting dubious objects. The broad visual streak of the horse retina apparently provides adequate breadth of sharp vision to monitor the surroundings for potential danger; minimal head adjustment is needed. Whereas, most animals must rely on their sound localization ability to properly orient the head and eyes in order to view objects with best vision.

Touch, Pressure, and Thermoreception

Tactile or touch perception occurs over most of the horse's body, with especially sensitive areas around the head. As handlers readily discover, horses avoid tactile stimulation in and around their ears. Innervation of hair follicles is widespread and commonly involved in tactile sensory perception. Specialized, stiff tactile hairs with sensory innervation at their base project beyond the remaining hair coat; these hairs are especially prevalent around the lips, nose, and eyes (Talukdar et al. 1972).

Sensory end organs occur in different forms within the skin. For example, in the dexterous upper lip of horses, three groups of sensory nerve endings are found: (i) endings with an inner core (lamellated and encapsulated), (ii) endings with auxiliary cells (non-lamellated but sometimes encapsulated), and (iii) free nerve endings (Talukdar et al. 1970). Capsulated endings seem to be limited to the dermis. Lamellated endings are oval and are covered by a thin capsule composed of one layer of cells. Within these capsules, a single lamella of squamous-like cells surround the nerve fiber in the center. The non-lamellated yet encapsulated endings are largest in the deeper layers of the dermis; disc and spray-like endings occur. Free nerve endings occur in the superficial dermis as well as into or just below the stratum granulosum of the epidermis. Such sensory end organs are thought to be associated with touch, pressure, and thermoreception.

Smell and Taste

Chemoreception in horses involves at least three receptor systems: (i) the olfactory nerve endings of the nasal cavity, (ii) the vomeronasal organ, and (iii) the taste buds. The olfactory nerve endings commonly associated with smell are located toward the posterior end of the elongated nasal cavity, specifically on the lateral masses of the ethmoturbinates, the adjacent part of the dorsal turbinates, and the septum nasi. The elongated olfactory cells are situated between supporting cells in a yellow-brown, non-ciliated epithelium. A tuft of fine, hair-like filaments extends from the olfactory cells into the nasal cavity. The other end of the olfactory cells form non-medullated nerve fibers leading to the olfactory bulb (Sisson and Grossman 1953). Literally millions of the olfactory receptor cells may be present.

The paired vomeronasal organ lies beneath the floor of the nasal cavity along each side of the anterior lower border of the nasal septum. The two parts of the organ extend posteriorly as blind-ended cartilaginous tubes about 12 cm long in smaller horses and 20 cm in large horses, ending caudally approximately opposite the third pair of cheek teeth. At the anterior end, along the floor of ventral meatus, the tubes open into a narrow recess through a slit-like orifice in common with the incisive or nasopalatine duct. Both tubes are lined with mucous membrane, supplied with blood by the sphenopalatine, and contain sensory fibers of the olfactory nerve (especially along the dorsomedial wall). In preserved material, the intraluminal diameter of each tube is about 3 mm and is mostly crescent shaped. Surrounding the epithelial lining of each tube is

a well-developed collagenous, highly-vascular cuff which resembles erectile tissue and contains abundant nerve tissue plus many mucosal glands (Minett 1925; Sisson and Grossman 1953; Lindsay et al. 1978; Lindsay and Burton 1983).

In *Equus* species the duct communicates only with the nasal cavity, thus odorous chemical substances enter the vomeronasal organ via the nasal cavity. Typically the horse first sniffs vigorously with its nostrils alternately close to, but not in contact with, the stimulus source (Figure 2.3a). The shape of the external nasal apertures can vary from circular to crescent-shaped slits, subsequently narrowing during lip-curl, neck elevation, and head extension of the flehmen response (see Fig 2.3b). During lip-curl, the upper lip is energetically retracted and elevated. This results in eversion of the central part of the lip, exposing its mucosal surface, and closure of the rostral parts of the external nasal apertures (Lindsay and Burton 1983).

The vomeronasal organ is facilitated by the animal filling its nasal cavity with odor laden air (such as in urine testing), constricting the external nares through the flehmen response, directing the air to the slit-like orifice and nearby fluids, elevating the head above horizontal, and allowing the chemical-laden particles to enter the vomeronasal ducts (Estes 1972; Lindsay and Burton 1983). A vasomotor pump-like mechanism may be involved (cf. Meredith et al. 1980). The flehmen response and liquid-borne compounds (non-volatile to low volatility) are generally assumed to be involved in vomeronasal sensory perception (e.g., see Wysocki et al. 1980). The response can be induced to a variety of odors and is not situation specific. Flehmen is often accompanied by the discharge of a clear nasal secretion, which on endoscopic examination seems to come from the narrow recess receiving the common opening of the vomeronasal organ and nasopalatine duct. Since the nasopalatine ducts are lined by non-secretory stratified epithelium, the observed secretions are likely produced by epithelial goblet cells as well as mucinous and seromucinous glands in the lamina propria of the vomeronasal tubes. Thus, the predominantly serous secretion seemingly permits an aqueous solution of odors to be sampled, followed by a rinsing of the organ in preparation for subsequent sampling (Lindsay et al. 1978; Lindsay and Burton 1983).

Functional significance of the flehmen response relates to olfactory investigation, often involving an attempt to determine the individual traits of conspecifics. Stallions exhibit flehmen more than other sex/age classes, often when investigating mares. Yet, it is incorrect to consider flehmen a type of sexual behavior. Mares and youngsters also exhibit flehmen.

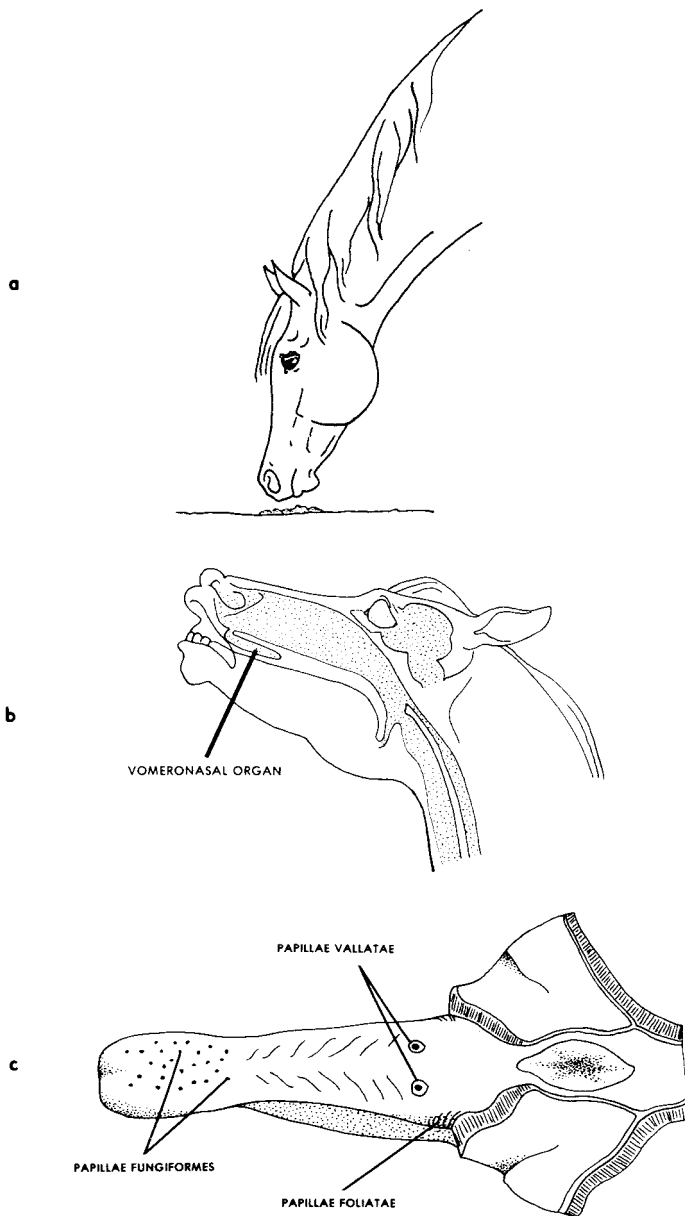


Figure 2.3: Chemoreception in horses: (a) typical olfactory investigation, (b) possible involvement of vomeronasal organ during flehmen, and (c) papillae where taste buds are located on the tongue.

Besides directly investigating a conspecific, the stimulus for flehmen by horses can be urine, feces, odorous objects on the ground, or even human fingers that have held a smoking cigarette. Mares often flehmen upon sniffing fluids associated with parturition. In a study of pasture-living mares and foals, colts exhibited flehmen more than mares and fillies; fillies exhibited multiple flehmen events more than mares (Crowell-Davis and Houpt 1985a).

Although Estes (1972) suggested the function of the vomeronasal organ was primarily for the detection of estrus, strong support is lacking for the horse. Marinier et al. (1988) found stallions living under horse-stable conditions showed no significant difference in response to odor of urine/vaginal secretions of an estrous mare from that when the mare was not in estrus. Perhaps, had the test stallions been open-range breeders, the results would have been different. Parameters analyzed were frequency, latency, and duration of flehmen as well as duration of responsiveness to the samples. The study found the stallions did differentiate between samples of individual mares but not with regard to estrous state.

Olfactory cues can enhance or inhibit other sensory cues and, therefore, can affect behavior. Wierzbowski (1959) found that when urine from estrous mares was sprinkled on a semen collecting dummy, young stallions showed an increased sexual response. Both mares and their foals recognize each other in part by odor. Disruption of both olfactory and visual cues can greatly impede the process of individual recognition (Wolski et al. 1980).

Chemoreception by taste involves the microscopic taste buds innervated by fibers of the glossopharyngeal nerve and the lingual branch of the trigeminal. The taste buds occur especially on the foliate, fungiform, and vallate papillae (Figure 2.3c) of the tongue as well as on the free edge and anterior pillars of the soft palate and the oral surface of the epiglottis (Sisson and Grossman 1953). The taste buds are barrel-like masses of taste cells embedded in the epithelium. Each bud has a minute opening called the gustatory pore through which small filaments, the microvilli of the taste cells, project.

The taste sensations perceived by the horse are presumed to be gradations of salt, sour, sweet, and bitter. Yet taste is not easy to analyze in animals and varies between species as well as between individuals. For example, the horse does not differentiate between pure water and an aqueous solution of sucraoctaacetate at concentrations which would be offensively bitter to humans (Kare 1971). Quinine solutions are rejected by horses once the concentration reaches 20 mg per 100 ml (Randall et al. 1978). The latter study,

using foals as test subjects, found sucrose solutions were preferred to tap water at concentrations ranging from 1.25 to 10 g/100 ml; below as well as above this range indifference was shown. The foals were indifferent to salt (NaCl) solutions until concentrations reached 0.63 g/100 ml; rejection then became typical as salt concentration increased. Sour perception was tested using acetic acid solutions; these solutions were rejected once their concentration reached 0.16 ml/100 ml and pH 2.9. Compared to other domestic species, foals respond most like sheep to sweet, salty, sour, and bitter solutions.

Horses choose and sort their foods using chemoreception and possibly tactile and visual characteristics. In this manner, poisonous plants are often avoided. The ability to choose appears to improve with maturity, but selective feeding varies depending on management practices, previous feeding opportunities, and factors such as season, hunger, condition of plant, time of day, and genetic background of the animal (Marinier 1980).

Proprioception and Equilibrium

As in other mammals, horses have muscle and tendon receptors that provide the central nervous system information on the extent of the stretch of the muscles and tendons. Such proprioceptive sensations provide the horse with information on the position of the various parts of its body without the need to monitor those body parts visually.

Equilibrium receptors are located in the inner ear embedded in bone along the temporal region on each side of the skull. These receptors, called the vestibular apparatus, consist of three fluid-filled loops (the semicircular canals) and two adjacent sac-like chambers—the utricle and saccule (Figure 2.4). The semicircular canals, arranged perpendicular to each other, each have at one end a spherical expansion (ampulla) that contains a crista with its sensory filaments. If the animal or its substrate moves or changes direction or speed, the fluid in one or more ampullae (and corresponding canals) move past the sensory filaments causing a neural impulse to be transmitted up the vestibular nerve. Thus the individual is made aware of any change in motion as well as changes in direction and speed.

Sensory areas in the utricle and saccule appear as small whitish thickenings composed of sensory cells with hair-like processes surrounded by support cells. Adhering to the surface of these receptors are fine crystals of lime salts, creating an otolith. As the head tilts, the otolith (crystal mass) shifts due to gravity and stimulates the sensory cells and the vestibular nerve.

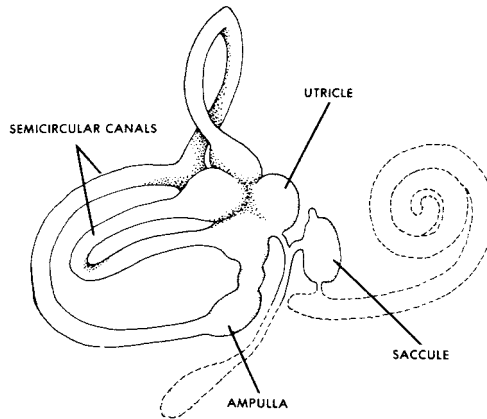


Figure 2.4: Equilibrium components of the inner ear (cochlea is the coil on the right).

Thus, among the various functions of the inner ear is equilibrium with respect to gravity as well as to change of motion, direction, and speed. The saccule also has a branch of the cochlear nerve, which suggests low frequency vibrations may be detected here as in some other vertebrate animals.

Pain

Observations suggest that pain in horses ranges from minor discomfort to extreme pain. Changes in posture and facial expressions, vocalizations (e.g., groans), loss of appetite, sweating, muscle tremors, as well as increase in pulse and respiration rate are among the indicators of pain (Müller 1942; Seiferle 1960; Walser 1965; Fraser 1969). Pain is exhibited widely throughout the body and seems to not need any specialized sensory organs for its reception; various physical and chemical stimulation directly to end fibers of sensory nerves can cause the sensation. Interoceptors, sensory fibers within the viscera, are involved in the discomfort evident during such ailments as colic.

Under stressful situations, individuals react differently to painful stimuli than they do in other situations. Selective perception or stimulus filtering seems to be involved. For example, responses to painful stimuli are diminished in foals during parturition until the pelvis has passed the vagina (Rossdale 1967a). Certain restraint techniques, such as using a twitch,

appear to function because the strong stimulus being applied at one site causes reaction to other stimuli to be temporarily reduced; perhaps endorphins are involved.

Orientation and Homing

Orientation in horses is an interplay of three main types—stabilization of posture and movement, object orientation, and orientation in the environmental context. The eyes, proprioceptors, otolith system, and semicircular canal complex enables stabilization of posture and movement independent of locality. When a horse moves toward or away from an object, any one or a combination of receptor systems may be involved, such as the visual, auditory, olfactory, or tactile system. It is common that a horse initially uses vision in its approach, then smell and touch, and finally taste when selecting food items.

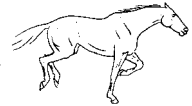
Within their environmental context, horses normally remain well oriented. The effects of gravity on the sensory structures of the utricle and saccule of the inner ear, as well as on proprioceptors, provide the animal with cues to maintain its physical balance against the pull of gravity. Visual cues provide further information about the location of landmarks, the horizon, the sun, and the stars. Tactile and kinesthetic cues inform the horse of the type of substrate and how far it has traveled. On windy days, horses tend to orient parallel to air currents while feeding and resting. And when they take advantage of heliothermy, they often orient their body broadside to the sun's rays on cold days.

Thus, a variety of sensory input and motor responses are involved in orientation. Whenever flight is necessary, or food, water, or comfort adjustment is required, the appropriate orientation is taken. Trails are often established and utilized along frequented routes. Long distance travel, such as to a water source 10 km away, appears to involve memory and landmarks.

Horses tend to follow the route of other horses. Vision undoubtedly is used to stay in the trail of a preceding horse. Yet Janzen (1978) observed an instance where smell also seemed to be used by a horse to verify the trail made about an hour earlier by a companion horse that had already traversed the coastal beach. The trailing horse kept its nose about 1 cm from the sand while searching for and verifying the intermittent trail at the water's edge. Each time tracks became evident, the horse raised its head to a normal height only after smelling the trail for at least 100m.

The tendency for horses to return home when given free rein has long fascinated horsemen. Homing seems to result from a combination of the desire to stay in a specific home range with known resources and a desire for social contact. Grzimek (1943b) and Williams (1957) attempted to investigate homing by allowing individual horses free choice of travel several kilometers from their home stable. The results were not supportive of a well-developed directional sense; nevertheless, the horses made attempts to locate surroundings familiar and congenial to them. Williams noted that there was a tendency for orientation into the wind regardless of the direction of home. Smell is important in social behavior and probably assists in homing. The ability of horses to utilize existing cues, such as faint odors, in addition to memory and trial and error, appears responsible for their homing capacity. A more elaborate navigation system in horses has not been demonstrated.

3 Motor Patterns



Motor patterns range from simple muscular twitches to complex locomotor activities. Movement of body parts is normally accomplished. Some motor patterns are done while the individual is stationary, such as a stretch, whereas other motor patterns achieve locomotion.

Reflexes

Among the most basic motor patterns of horses are those associated with reflex arcs. They involve relatively few sensory-motor units, keeping the neural as well as muscular involvement simple. Since reflexes are stereotyped and involuntary responses to a given stimulus, they are useful to veterinarians to determine not only stages of anesthesia but also soundness of the neurological system (Rooney 1971; Catcott and Smithcors 1972). For example, a slight tap of the side of the neck just posterior to the ear will cause the ear on that side to turn forward (cervico-auricular reflex) provided the sensory components of the most anterior cervical tracts and the pathway through to the facial nerve and auricular muscles are functioning properly (Rooney 1973).

Associated with the head are a variety of reflexes of the eyes, ears, nose, and mouth (Table 3.1). Tapping the bone just below the eye, for example, causes the palpebral or eyelid reflex shown as a blink. An object visually perceived nearing the eye as well as corneal stimulation causes additional blink reflexes. Material in the eye induces the lacrymal reflex. Sudden bright light causes pupil constriction called the pupillary light reflex. Tonic eye reflexes keep the eye looking in the original direction when the head is moved. Distinctive sounds cause ear twitching characteristic of the Pryer reflex. The head shake reflex occurs with tactile stimulation of the hairs of

the ears. Tactile stimulation around the mouth of a newborn foal initiates the sucking reflex. As solid foods are eaten by horses, the mastication reflexes modify chewing activity to protect the tongue and other tissues from harm. The salivary reflex occurs when material enters the mouth. Stimulation of the nasal mucosa causes the sneeze reflex, whereas stimulation of laryngeal mucosa induces the cough reflex.

Some reflexes are associated with posture and body orientation (cf. Rooney 1971). With tilting the head up or down and not altering the neck position, the vestibular reflexes occur; upward head extension tends to flex forelimbs and extend hindlimbs, whereas ventroflexion of the head induces hindleg flexion and foreleg extension. If the head is kept in a normal position and the neck only is moved, then the tonic neck reflexes occur; dorsiflexion of the neck tends to flex the hindlimbs and extend the forelimbs, whereas ventroflexion of the neck causes forelegs to flex and hindlegs to extend. Pressure on the soles of the feet causes leg extension (extensor thrust reflex), thus a horse stands without conscious thought. When pressure is applied to the side of a horse, the near legs tend to flex and the opposite legs extend (sway reflexes involving crossed extensor response). Pressure on the croup induces flexion or tucking at the lumbosacral joint. Pressure at the lumbosacral junction causes upward tilting of the pelvis and hindleg extension; pressure near the thoracolumbar junction promotes dorsiflexion of the back (vertebra prominens reflexes).

Table 3.1: Some Reflexes of the Horse

Eye, Ear, Nose, and Mouth Reflexes:	Postural Reflexes:	Miscellaneous Reflexes:
Palpebral reflex	Vestibular reflexes	Panniculus reflex
Corneal reflex	Tonic neck reflexes	Abdominal
Lacrymal reflex	Sway reflexes	cutaneous
Visual blink reflex	Vertebra prominens	muscle reflex
Pupillary light reflex	reflexes	Perineal reflex
Tonic eye reflexes	Labyrinthine reflexes	Local cervical reflex
Cervico-auricular reflex	Segmental static reflexes	Withdrawal reflex
Pryer reflex		Kicking reflex
Head shake reflex		Bucking reflex
Sucking reflex		Thrusting reflex
Mastication reflexes		Ejaculatory reflex
Salivary reflex		Spinal visceral
Sneeze reflex		reflexes
Cough reflex		

Labyrinthine reflexes reacting to gravity are involved during righting responses, such as when a horse lying on its side raises and levels the head with the neck twisted to achieve sternal recumbency. Supporting and placing reflexes also assist posture and coordinated motor activity, such as the segmental static reflexes where as one leg leaves the ground the other legs extend in response.

Additional reflexes occur throughout the body for various other biological functions. For example, the panniculus reflex causes twitching of cutaneous musculature when the skin is pricked or stimulated by biting insects. Tactile stimulation of the hairs along the costal (rib) arch induces cutaneous muscle contraction, especially of the flank (abdominal cutaneous muscle reflex). Tactile stimulation of the tissues near the anus causes the perineal reflex; the anal sphincter contracts and the tail is clamped down (except in estrous females or those nearing parturition). Tapping the side of the neck between cervical vertebrae 3 and 5 causes local muscular contraction (local cervical reflex). A noxious stimulus applied to the distal portion of a limb causes the withdrawal reflex. Moving a hand along the hindleg of a foal tends to cause the kicking reflex, whereas moderate pressure on the kidney region of the back induces bucking in very young foals. Grzimek (1949a) found the latter response disappeared on the eighth day of age in the foal he studied. As stallions develop sexually, the thrusting reflex of the pelvis eventually accompanies mounting, and associated with high sexual excitation is the ejaculatory reflex. Spinal visceral reflexes control urination and defecation.

—Locomotor Activity—

Based on fossil evidence, postures and movement patterns of equids have changed as a result of evolutionary changes in body and limb morphology (see Sondaar 1969). Locomotor characteristics have changed concurrently with anatomical and physiological changes. With body size increases, it became necessary for alterations to occur in the proportions of the running apparatus and elsewhere in the body in order to retain swift locomotion (see Hildebrand 1987). Thus, the movement patterns of the domestic horse are the result of millions of years of selective processes. The reduction of toes until the single central digit supported body weight led to corresponding adaptations in leg structure. Besides lengthening of the limb bones and changes to prevent lateral movement of joints, the

development of the so-called spring ligaments was significant. With these elastic ligaments and with maximum flexibility of the fetlock in the anterior-posterior direction, a spring-like mechanism resembling the effect of a pogo stick was created. Within limits, the harder the impact on this apparatus the higher the bounce. This type of foot was obviously very effective on firm soil, extended the endurance of the animal, and permitted a size increase yet maintained speed. Locomotion continues to be fundamental to every horse.

Locomotor activity in healthy foals begins within minutes following birth and continues to serve biological needs throughout the life span. In a horse's world, little can be accomplished without moving about. For example, Feist (1971) found the feral horses he observed along the Wyoming-Montana border sometimes needed to travel each day as much as 16 km from their feeding site to reach a water hole for a drink. A newborn foal must stand and move about to search for its first meal, just as an older horse must move about to feed and obtain water. Soon after birth, a foal can travel swiftly with its mother for short distances. In their prime, some grown horses can attain a speed of more than 65 kph (40 mph) for nearly a kilometer. A distance of 32 km (20 miles) can be covered in one hour by many horses (Hildebrand 1959); the pony express horses in the American west demonstrated such power and endurance during 1860–1861.

Normal locomotor activity of horses can be inhibited by physical, chemical, and psychological restraint or disrupted physiologically as a result, for example, of trauma, infections, or toxicity. An active horse subsequently restricted in forward locomotion often exhibits pawing, seemingly as a displacement act (Ödberg 1973). Littlejohn (1970) noted that horses recovering from general anesthesia spent fractionally more time walking but walked much more slowly during the first 30 minutes of standing than when normal.

The area of the cerebral cortex where somatic motor activity can be elicited occupies nearly the entire rostral half of the dorsal surface of the cerebral hemispheres. Electrical stimulation of this part of the brain has shown there are four distinct motor regions. That is, stimulation with electrodes from anterior to posterior causes (i) contralateral upper and lower lip movement, (ii) contralateral nostril dilation, (iii) contralateral shoulder and neck movement, and (iv) contralateral limb movement (Breazile et al. 1966). The last area is especially important in locomotion; such motion is coordinated through the cerebellum. Horses show a slight individual,

but not species specific, tendency toward either right or left handedness (Grzimek 1949b).

Not only do the legs have a role in locomotion, the neck, spine, and associated muscles play a part as well. Various parts of the body together with the vestibular apparatus of the ear also have a role in postural reflexes. Relative to many smaller mammals, the equid spine arches little during galloping strides; the withers to ground distance remains relatively constant, the croup to ground distance varies only slightly, and the chest to buttock length changes only moderately during a stride (Hildebrand 1959). Nevertheless, during a vigorous gallop (13 m/sec), the angular displacement of the neck can be 28° with this variation occurring systematically during the stride (Figure 3.1). The downswing of the neck begins during the suspension or flight phase of the stride and continues in a nearly linear manner as the first three feet contact the ground. As the hindlegs leave the ground, the neck begins the upswing, reaching a maximum as or shortly after the lead foreleg leaves the ground. Rooney (1978) postulated that if the muscles forming a mechanically continuous system from the cervical to the thoracic vertebral column (Figure 3.2) were to hold in isometric contraction, then as the neck moves down, the body in effect would be pulled forward, contributing to linear forward motion of the horse. The historical roots of locomotor research have been reviewed by Leach and Dagg (1983a,b).

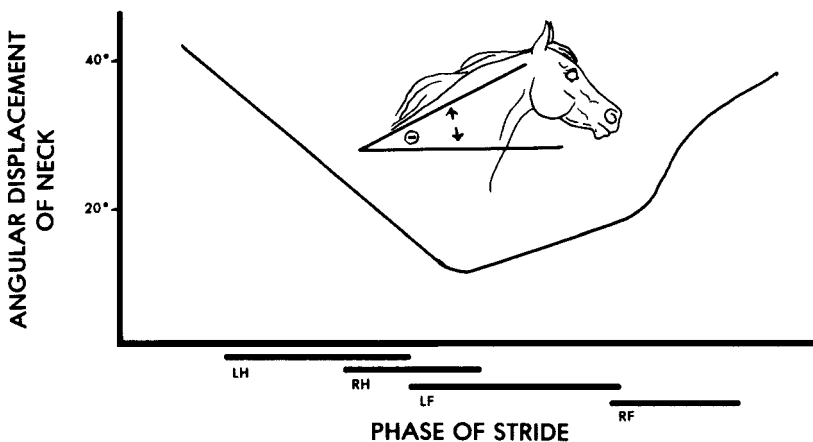


Figure 3.1: Angular displacement of the neck during a racing gallop correlated with the support periods of the individual legs—left hind (LH), right hind (RH), left fore (LF), and right fore (RF). (After Rooney 1978)

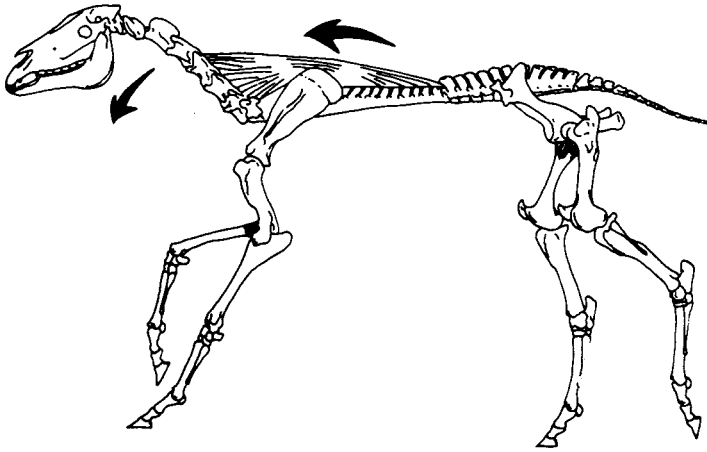


Figure 3.2: Musculature involved in lifting the body forward as the neck moves downward. (After Rooney 1978)

Much still remains to be learned about the biomechanics of equine locomotion. The current level of knowledge is reviewed in the publication edited by Back and Clayton (2001).

Gaits

The specific gaits of horses reflect not only anatomical characteristics but also a balance between energy expenditure and environmental context. The walk permits locomotion with a minimum energy output. When more speed is necessary, the trot or a slow gallop is used. And finally for bursts of extreme speed, a vigorous gallop occurs (cf. Tricker and Tricker 1967).

The natural gait at any speed would seem to entail the smallest possible energy expenditure (Hoyt and Taylor 1981); however, horses were observed to switch from a trot to a gallop at the speed (4.1 m/sec) that was 13 percent higher in energetic cost than for trotting (Farley and Taylor 1991). Heglund et al. (1974) found stride frequency and stride length both increased with increasing speed; however, within a gallop, speed was increased primarily by increasing stride, whereas frequency remained nearly constant. Because of the nearly constant stride frequency in the gallop, Heglund and his co-workers concluded the transition from trot to gallop occurred at the maximum sustained stride frequency of the animal. Farley and Taylor (1991) determined horses switched from a trot to

a gallop at essentially the same level of force whether or not added weight was carried; however, this level of force was reached at a lower speed when the horses carried weights (3.3 m/sec versus 4.1 m/sec). They concluded musculoskeletal forces trigger the trot-gallop transition to maintain a certain safety factor for avoiding injuries.

The gaits of walk, trot, and gallop are natural to all horses. Movement backward in a walk-like pattern (backing) can occur but is seldom extensive. Gaits such as the slow gait, running walk, and rack are considered acquired since the horse industry has selected for and trained certain horses to perform such movements. The pace can be either natural or acquired. As might be expected, gradations occur as a horse moves from one gait to another or changes speed. Terminology pertaining to gaits varies considerably from one breed association to the next and from one geographical region to another. No attempt in this book will be made to cover them all.

Walk: The *walk* typical of horses is what Magne de la Croix (1936) called a diagonal walk. All the limbs move sequentially one after the other as follows: left fore, right hind, right fore, left hind. Since each hoof hits the ground individually (Figure 3.3a), a walking stride consists of four beats. There is an alternation of between two and three legs supporting the body weight during this gait. In an ordinary stride, the hindfoot more or less covers the print made by the forehoof on the same side; a tired horse will usually place the hindfoot short of the impression made by the forefoot. Saddle horses tend to have a stride of about 5.75 m and average approximately 6.5 kph (4 mph) when walking (Grogan 1951). A 0.6 to 1.0 stride per second is common (Hildebrand 1965).

A variation of the walk occasionally seen in horses is the lateral walk (Figure 3.3b) which often progresses into the pace. In this variation the first foreleg to move is followed by the hind on the same side, then the other foreleg moves and finally the hind on its side.

Trot: The *trot* is a two-beat gait in which the two diagonal feet work as a pair and are either lifted synchronously or on the ground at the same time (Figure 3.3c). The footfall pattern is: (a) left fore, right hind, (b) right fore, left hind. The trot provides the animal with greater balance than does the pace. After each diagonal pair leaves the ground there is normally a brief moment where the animal is not supported by any legs until the other pair makes contact again with the substrate. The animated form of the trot, such as shown by a displaying stallion, is often called *prancing*. The speed of

the trot commonly is in the range of 10–14 kph (6–9 mph); racing trotters, however, often average 50 kph (30 mph). During the trot, the legs flex more than in the walk.

Pace: The *pace* or *amble* is another two-beat gait where legs on the same side act in unison (Figure 3.3d). As in the trot, there are two periods during each stride where the body is suspended or in flight. The footfall pattern is: (a) left fore, left hind, (b) right fore, right hind. The pace is not a natural gait for most horses. When it does occur or is taught, its speed is similar to that of the trot.

Gallop and Canter: The *gallop* (Figure 3.3f) and its more restrained version, the *canter* (Figure 3.3e), are basically four- and three-beat gaits, respectively. A diagonal or transverse gallop best describes the footfall pattern typical of horses versus the lateral or rotary gallop typical of, for example, rabbits or the cheetah. As a cantering or galloping horse proceeds to contact the ground following the flight phase, it uses one of the following mirror image patterns:

- | | | | |
|----|--------------------------|-----|--------------------------|
| I. | a) left hind | II. | a) right hind |
| | b) right hind, left fore | | b) left hind, right fore |
| | c) right fore* | | c) left fore* |

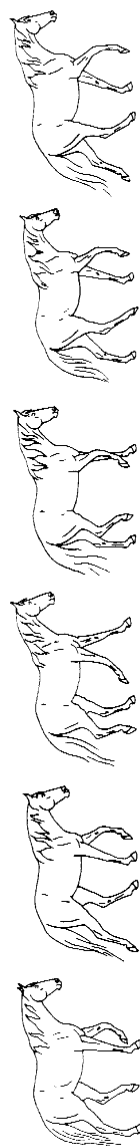
* lead foreleg

In the typical canter, the second and third legs contact the ground simultaneously; in a full gallop, the hindlimb of that pair (b) contacts the ground first, giving a four-beat rhythm instead of a three-beat. The body pivots over the lead foreleg, and it is the last leg lifted before all legs are again off the ground.

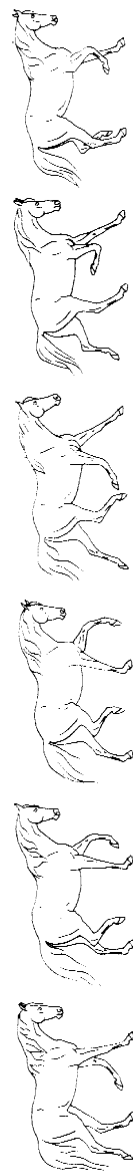
As a horse leans or turns to the right, it normally leads with its right foreleg, and if motion is leftward so also is the lead on the left. Lead changes can occur by switching the footfall pattern of the forelegs subsequent to the hind contacting the ground or more commonly during the suspension phase of the stride by placing the other hindleg down first (shifting from the above-noted pattern I to II, or vice versa). Riders often school their horses to change leads upon command. When free to choose, horses change leads in the canter or gallop when alternately changing direction, perhaps to avoid limb interference or maintain stability; they also may change leads to reduce fatigue (Hildebrand 1959).



(a) diagonal walk



(b) lateral walk



(c) trot

Figure 3.3: Locomotor patterns in the horse.

Continued on next page



(d) pace



(e) canter



(f) gallop

Figure 3.3: Locomotor patterns in the horse.

Continued on next page



(g) slow gait



(h) rack



(i) running walk

Figure 3.3: Locomotor patterns in the horse.

A slowed gallop becomes a canter. As the canter is slowed or animated considerably, the three-beat characteristic may shift to a four-beat pattern as the second and third legs begin to contact the ground separately rather than together. The speed of the canter is approximately 16–19 kph (10–12 mph). A more natural gallop would be about 26–29 kph (16–18 mph), with a maximum racing gallop of 64–69 kph (40–43 mph). In the gallop, a horse covers usually 5.8 to 7.6 m per stride and at 56 kph (35 mph) completes about 2.3 strides per second (Hildebrand 1959; 1977).

Slow Gait: The so-called *slow gait* of five-gaited show horses is one of the acquired gaits (Figure 3.3g). It is generally a very animated, slow, broken pace (sometimes called a stepping pace). Although the legs of the same side leave the ground together, the hind returns before the high-stepping foreleg. One to three legs support the body at any one time.

Rack: The *rack* (tolt) is another of the gaits of five-gaited show horses (Figure 3.3h). It follows the leg pattern of the walk but is faster and more animated. High foreleg action occurs. The rack is particularly fatiguing for the horse. Hildebrand (1965) noted that a given horse may complete 1.6 to 1.8 strides per second in a slow gait and 2.0 to 2.1, at the rack.

Running Walk: The *running walk* is the acquired gait distinctive of the Tennessee Walking Horse. It is the fastest of the four-beat show gaits, exceeding 32 kph (20 mph). The gait has a smooth gliding motion with forelegs extending greatly (Figure 3.3i). High animated leg lift is not typical but usually encouraged. Enormous steps are taken in an accelerated walk footfall pattern. The head and neck nod up and down as the forelegs are advanced. Hildebrand (1965) found 1.5 to 2.2 strides per second were completed in the running walk.

Other Motor Patterns

Two Tracking: Horses show a great variety of motor patterns other than those already mentioned (see Table 3.2). For example, during a walk or slow trot, a horse can shift from a direct line of travel (single track) to a sideways motion of varying degrees in what is often called *two tracking*. With sideward flexion of the back, such locomotion can occur in the direction of flexion (*traver* or *renver*) or with the convex curve of the body leading (i.e., *shoulder-in*). Some degree of leg crossing occurs in such maneuvers.

**Table 3.2: Motor Patterns, Postures, Emissions, and Other Behavior Patterns
Characteristic of the Horse Ethogram**

(see text and illustrations for clarification)

Alert	Head threat	Running walk
Approach	Head toss	Scratch
Arched neck	Head turn	Scream
Avoidance-retreat	Hindleg lift	Shake
Back	Hindleg stretch	Shiver
Balk (Jib)	Interference	Shy
Ballotade	Jump	Skin twitch
Bite	Kick	Sleep
Bite threat	Kick threat	Slow gait
Blink	Kneel	Smack
Bolt	Knock	Snaking
Boxing	Lateral recumbency	Snapping (Teeth-clapping)
Buck	Levade	Sniff (Smell)
Buck-jump	Lick	Snore
Canter	Lie down	Snort (Blow)
Capriole	Look	Spread-hindlegs stance
Chase	Lunge	Squeal
Chew	Marking (fecal, urine)	Stomp (Stamp)
Circling	Masturbation	Stand
Copulate	Mezair	Stare
Cough	Mount	Sternal recumbency
Courbette	Mutual groom (Allogroom)	Strike
Cribbing	Nasogenital investigation	Strike threat
CroupadeDancing	Nasonasal investigation	Suck
Defecate	Nibble	Sunning
Drink	Nicker	Supplant
Driving (Herding)	Nip	Swallow
Drowsy	Nodding (Bowing)	Swim
Ears laid back	Nostrils flared	Tail depression
Ears lateral	Nurse (Suckle)	Tail flagging
Ears pricked	Pace	Tail raise
Ejaculation	Parturition	Tail switching
Eye roll	Passage	Tongue manipulation
Flehmen	Pawing	Tongue rolling
Follow	Pelvic thrust	Traver
Foreleg lift	Penis erection	Trot
Gallop	Penis extension	Two tracking
Getting up	Penis retraction	Vulva winking
Groan	Piaffe	Upper lip movement
Grasp	Pirouette	Urinate
Grunt	Prance	Wait
Hay dunking	Push	Walk (diagonal)
Head bump	Rack (Tolt)	Walk (lateral)
Head extension	Rear	Weaving
Head flexion	Renver	Whinny (Neigh)
Head upon another horse	Roll	Windsucking
Head shake	Rub	Yawn
Head stretch	Rump presentation	

Ethologists who have especially developed equine ethogram material with illustrations include Feist and McCullough (1976), McDonnell and Haviland (1995), Bettina (von Goldschmidt) Hughes, and Angela Glatthaar.

Circling: Turning during locomotion, especially continuous tight turns (*circling*), can involve leg crossing. Turns can be pivotal primarily around the forelegs or around the hindquarters (e.g., *pirouette*). In the *pirouette* the forelegs describe a larger circle than the hindlegs (Seunig 1956).

Piaffe and Passage: Leg motion can occur with little or no forward movement of the body. When a horse maintains a lofty, sustained trot-like action while remaining in place, showing springiness in its leg movements, it is called *piaffe*. When similar leg motions create a slow forward floating movement, it is referred to as the *passage* (the parade step of the ancient Greek horses).

Swimming: Horses while *swimming* maintain leg movement in a sequence resembling the trot. The head is elevated, keeping the eyes and nostrils above the water surface.

Jumping: Horses exhibit *jumping* over high elevated obstacles as well as over ditches and similar obstacles requiring broad jumps. In both cases, the forelegs are raised clear of the obstacle while the animal continues to propel forward with a final push by fully extending the hindlegs (Figure 3.4a). At take-off the hindfeet are commonly at the site where the forelegs left the ground (cf. Leach and Ormrod 1984). The forelegs flex close to the chest as elevation is gained, extending subsequently to alight either simultaneously or sequentially as the hindlegs are momentarily flexed clear of the obstacle. The animal is fully off the ground during the jump. Occasionally while jumping, horses rotate the hindquarters to one side as the hindlegs reach maximum flexion. Although jumping can occur from most gaits, the running jump occurs usually from a canter or a moderate gallop.

Rearing Motions: Rearing is a motor pattern where the hindlegs remain on the ground while the forequarters raise high into the air (Figure 3.4b). Two rearing horses with their chests in contact or nearly so are said to be *dancing*. A controlled movement by one horse where the forelegs are tightly flexed as the forequarters are moderately raised placing the spine 30–45° above horizontal is called the *levade* (Figure 3.4c). The weight is borne by the deeply flexed hindquarters. The greater this flexion the longer the horse can maintain the position. The *mezair* is a series of levade movements combined with forward motion accomplished by smooth jumps where the forelegs alight briefly followed by the abrupt alighting of the hindquarters.

An in-place leap or hop upward in a rearing-like attitude from the levade is called a *croupade* (Figure 3.4d), whereas a similar leap on the hindlegs where forward advance occurs is the *courbette* (Figure 3.4e).

More than one leap may be induced before the forelegs again contact the ground. Such gymnastics are achieved by extensive development of muscle and coordination through training. Two other in-place leaps can be obtained from highly schooled horses. The *ballotade* is a high leap where the legs are flexed underneath with the hindlegs retracted as if ready for a kick (Figure 3.4f). In the *capriole* (Figure 3.4g) the hindlegs do kick posteriorly during the leap (Seunig 1956).

Bucking: A sudden humping or arching of the back with head and neck quickly lowered is called *bucking* (Figure 3.4h). Kicking with both hindlegs may follow. Frequently the horse also leaps or bounds clear of the ground, exhibiting what is called a *buck-jump* (Figure 3.4i). A horse usually performs these movements to rid itself of something on its back, as riders sometimes discover. A series of these motions can occur with leaps in erratic directions. Exuberant, playful horses while galloping at liberty sometimes exhibit bucking followed by a kick.

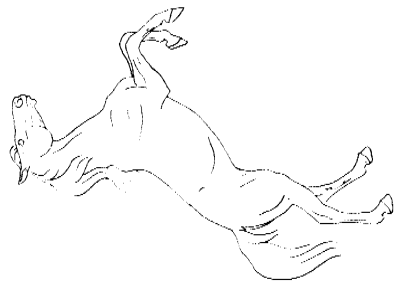
Kicking: Kicking with one or both hindlegs, while the forelegs remain in contact with the ground, is a common aggressive pattern of horses (Figure 3.5a). The suddenly flexed and elevated hindleg or legs are thrust quickly posteriorly as the weight is shifted over the forelegs. The neck may be lowered in the process. Two related motor patterns occur. One is *knocking* of the substrate (Figure 3.5b) with a hindleg. (A similar raising and lowering of a foreleg is called *stomping*.) The other is a *hindleg lift* used often by mares to block or bump away a foal, using the stifle to prevent access to the udder. Each of these movements can be forceful.

Striking: Striking is the often swift motion made by one or both forelegs in an anterior direction (Figure 3.5c) usually to hit or threaten another individual. Often it occurs with one leg while the other foreleg remains in contact with the ground. The neck is usually elevated. Striking can be done also by a horse during rearing; when two horses interact in this fashion it is called *boxing*.

Pawing: Pawing is similar to striking with a single leg except pawing is slower and the toe is dragged posteriorly in a digging or scraping motion (Figure 3.5d). When used during investigation, the nose is usually oriented toward the substrate or object. Pawing is commonly repeated several times in succession. In addition to its use in scraping, Ödberg (1973) noted that pawing is occasionally exhibited as a displacement activity by horses restricted in forward locomotion. During such occasions, contact with the ground may be incomplete and the head and neck often remain elevated.



(a) jumping



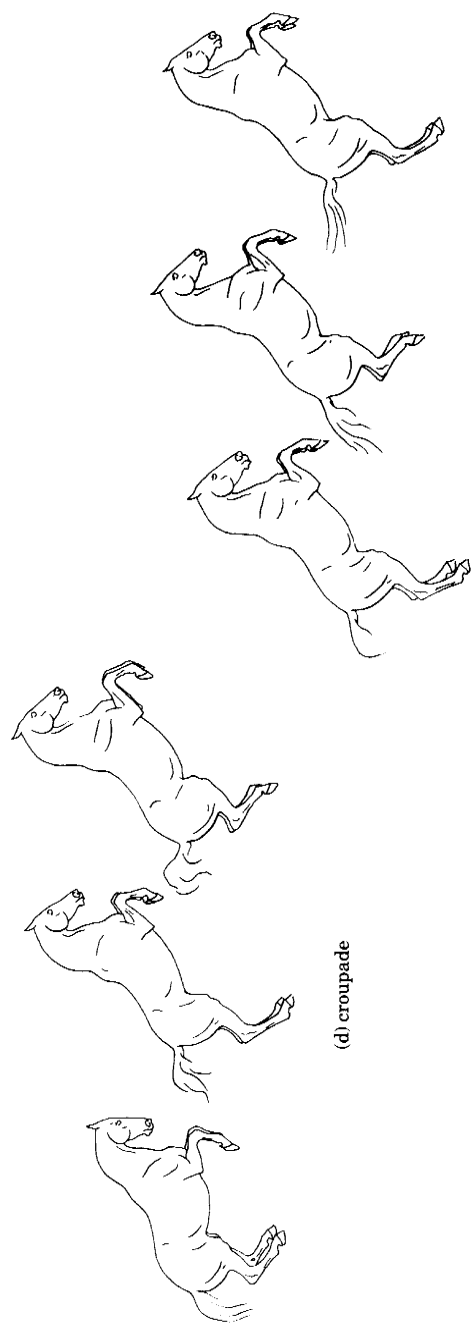
(b) rearing



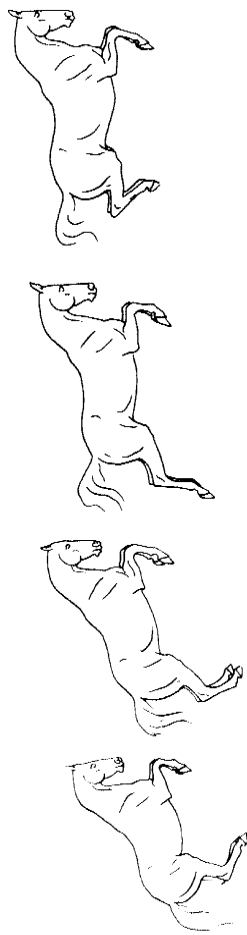
(c) levade

Figure 3.4: Jumping, rearing, and leaping motor patterns of horses (see text for details).

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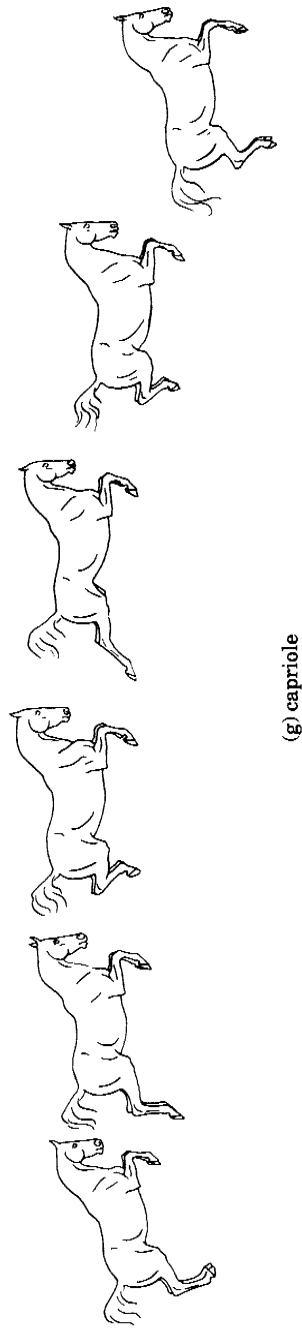
(e) courbette



(f) ballotade

Figure 3.4: Jumping, rearing, and leaping motor patterns of horses (see text for details).

Continued on next page



(i) buck-jump

Figure 3.4: Jumping, rearing, and leaping motor patterns of horses (see text for details).

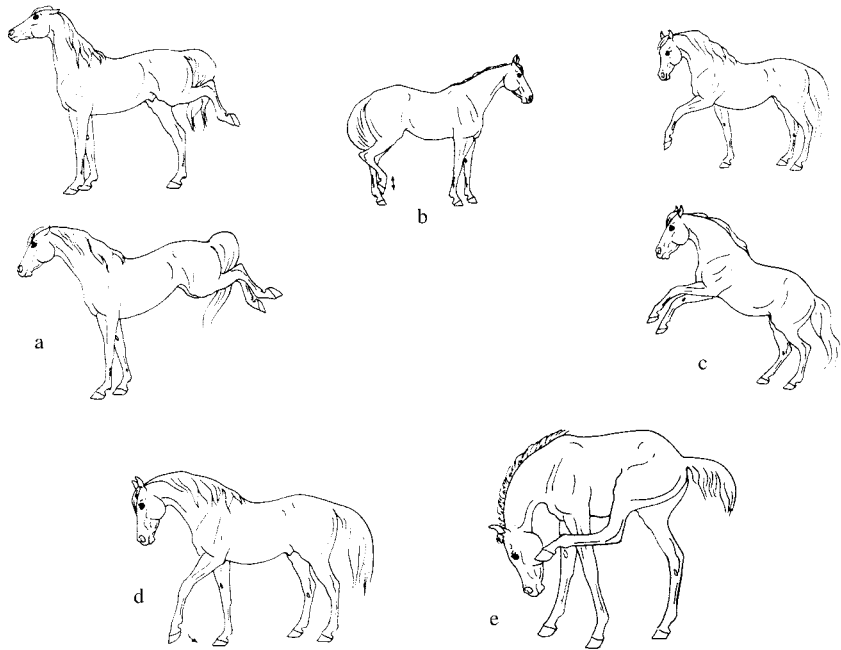


Figure 3.5: Additional leg movements of horses: (a) kicking, (b) knocking, (c) striking, (d) pawing, and (e) scratching.

Scratching: Scratching with a hindfoot is often done by young horses and occasionally by adults, such as ponies. The body is flexed to one side and the hindleg on that side is extended forward so the hoof rubs the lowered head or neck (Figure 3.5e).

Pushing: Pushing is where a horse presses against something in an attempt to displace it. For example, the neck, shoulder, or thigh is used to push other organisms; the chest is often used to push against barriers. A *head bump* is a variation of pushing.

Lying Down: Lying down is the process of going from a standing to a recumbent position. It is a continuum of motor patterns (Figure 3.6a) that may commence with the horse investigating the substrate with nostrils near the ground. Sniffing, circling, and trampling may ensue. If rolling is to occur, pawing of the substrate often takes place. Next the legs gather close together, often with a piaffe-like movement, with the head remaining low. Having positioned the legs, the forelegs begin to bend at the knees.

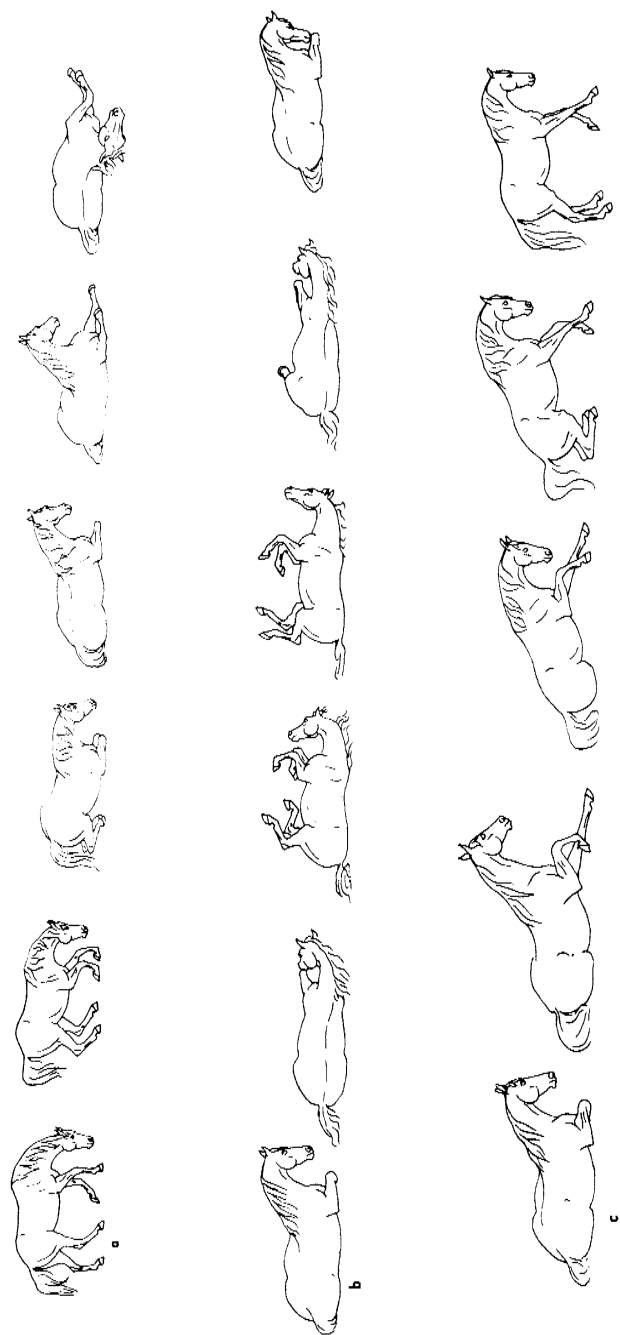


Figure 3.6: Motor patterns of (a) lying down to sternal and then lateral recumbency, (b) rolling, and (c) getting up.

As the forequarters slowly sink, the neck and head move forward. The body weight is concentrated on the somewhat flexed hindlegs. The forequarters continue to sink, and the head is kept well forward. As the knees are about to contact the ground, the hindlegs fold, the neck elevates, and the body is abruptly lowered to the substrate. At this point, the horse is in *sternal recumbency*, resting somewhat on one side in such a way that the sternum and abdomen rest on the ground to either the right or left of the midline with head and neck upright. The legs remain flexed with only one hindleg extended free of the body.

To go completely prone to *lateral recumbency*, the horse rolls further onto its side and somewhat extends its legs while lowering the neck and head to the substrate. The upper foreleg is commonly anterior to the lower forelimb which is often slightly flexed at the carpal and fetlock joints (Littlejohn and Munro 1972). Either of the extended hindlegs can be slightly anterior to the other.

Rolling: Rolling is accomplished while recumbent by rotating onto the back with flexure of the legs (Figure 3.6b). The head and neck appear to assist in the effort to roll by providing leverage for the sudden body twist. The extent of the roll commonly stops along the back with muzzle pointing skyward; however, the animal may roll over completely onto its other side. If the latter occurs or the roll is inadequate, the horse often attempts to return to its back where it may rub against the substrate with legs thrashing as the back flexes laterally back and forth. After a few seconds, the horse returns to sternal recumbency.

Getting Up: The process of *getting up* onto the feet begins with the position of sternal recumbency. The weight is shifted posteriorly by elevating the neck as one foreleg then the other extend anteriorly lifting the forequarters clear of the substrate (Figure 3.6c). As one or both forelegs become stabilized, the neck lowers allowing the weight to shift anteriorly, and the hindquarters are raised by the hindlegs. On rare occasions, a foal varies the process and stands by first raising the hindquarters, reversing the sequence of lying down.

Shaking: Shaking is where the surface of the body as well as head and neck are rotated or vibrated rapidly. This frequently occurs after rolling. The entire animal vibrates momentarily casting away dust and other matter from the pelage. Localized quivering of the skin (*skin twitching*) occurs in response to localized stimulation of the skin, for example, by insects. Insects and other annoyances around the head and ears cause *head shaking*.

Rubbing: Rubbing can occur, for example, by a horse moving its lower jaw surface or muzzle against its forearm or by moving any part of the body back and forth or up and down against some object. *Licking* with the tongue and *nibbling* with the incisors are other motor patterns often directed at the pelage during grooming.

Mouth Movements: Biting motions are often directed at another horse by extending the head and neck while opening the mouth and directing the incisors at the other individual. If contact is made, a *bite* occurs; if maintained, it is a *grasp*. The feigning of a bite without making contact is a *bite threat*. An acoustical variant of bite threat used by mares toward their nursing foal is called *smacking*; the mare, with ears laid back, turns the head and neck toward the foal while the mouth is abruptly opened creating a smacking sound (Crowell-Davis 1985). *Cribbing* is the pushing of the upper incisors against a fixed object and involves the musculature of the neck and head (see Chapter 25).

Motor patterns commonly involved in feeding are *upper lip movements* to separate and help lift food material, biting and cropping food with the incisors, use of the tongue to move the food into the mouth (*tongue manipulation*), chewing the material with cheek teeth by crushing and lateral grinding motions of the lower jaw, and finally *swallowing*. While chewing dry roughage, some stabled horses periodically immerse a mouthful into water using a motion called *hay dunking*, apparently to moisten the food (Waring 1974). Some horses acquire an abnormal trait of *tongue rolling*, where the mouth opens and the tongue is maneuvered, often in exaggerated fashion, on one side and then the other.

The *sucking* pattern of a foal is displayed by extending the head and usually elevating it above horizontal while protruding slightly the receptive tongue flattened against the lower incisors. Sucking readily occurs once the tongue makes contact with a teat or surrogate object. Occasionally neonates exhibit sucking in mid-air prior to successful nursing.

Immature horses especially, during submission or when apprehensive about the nearness of another individual, occasionally display an up and down movement of the jaw while the lips are retracted at the corners of the mouth. This nearly-silent display has been called *snapping*, teeth-clapping, Unterlegenheitsgebärde, champing, jaw waving, and so on. It is often displayed by a submissive individual who is in a conflict situation of wanting the closeness of the more dominant individual, yet is timid and apprehensive at the same time.

Head Movements: The head is capable of a variety of other motor patterns, some of which will be covered later under communicative behaviors. *Nodding* is the oscillatory movement of the neck in the vertical plane, causing the head to change elevation; an *arched neck* is often involved. Some horses are taught to momentarily hold a lowered neck position in what is called *bowing*. *Head tossing* is a similar motion up and down but head flexion and extension is primarily involved. *Weaving* is a repetitious, relatively-slow, lateral motion of the head and neck, where commonly the weight is shifted alternately from one foreleg to the other.

The behavior pattern called *flehmen* (Figure 3.7) is where the head is elevated and the upper lip is raised, wrinkling the nose and exposing the gums. Such motor patterns occur in a variety of mammals, including most ungulates and felids (Schneider 1930; 1931; 1932a; 1932b; 1934). In the horse, flehmen begins with extension and elevation of the head, usually after sniffing something. As the head approaches extreme extension, the upper lip is lifted maximally exposing the upper incisors and adjacent gums. The jaw is usually closed or nearly so. The ears and eyes generally rotate to the side (Dark 1975), and the third eyelid (nictitating membrane) appears as a whitish area covering the anterior portion of the eye. At its peak, the head is raised above horizontal. In less than one minute, the head posture and facial features return to normal.

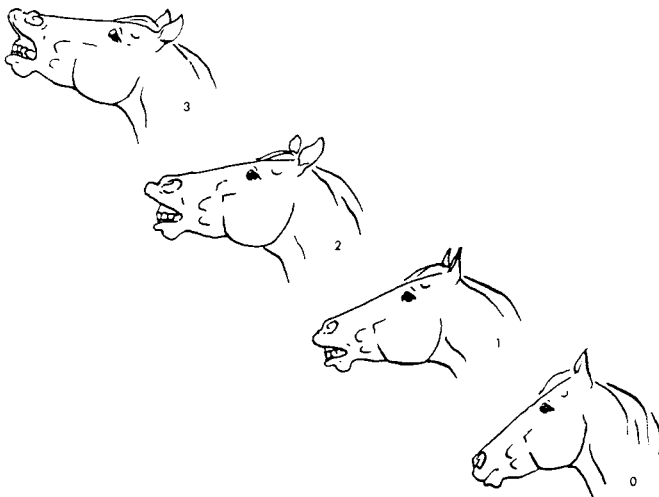


Figure 3.7: Sequence of the flehmen response. (Adapted from Dark 1975)

Horses also *yawn*. The yawn begins from a relaxed head position while either standing or recumbent. The mouth starts to open, and a deep inhalation occurs as the head is raised and extended. The eyes roll and close, at least somewhat, as the yawn reaches its peak (Figure 3.8). The elevated head sometimes turns and rotates slightly. The lower jaw may shift laterally when the mouth is wide open, and the otherwise relaxed ears may shift forward momentarily. Exhalation occurs quietly as the yawn regresses (Dark 1975).

Stretching a portion of the body occurs most often by either moving one hindleg (*hindleg stretch*) posteriorly fully extended, often while raising and lowering the back, or by elevating and sometimes extending the head (the *head stretch*). Such movements often occur after a yawn or a period of rest.

Eye and Ear Movements: Eye and eyelid movements occur. *Eye rolling* is where the eye rotates downward or posteroventrally and retracts exposing white scleral tissue above the pigmented iris. During eye rolling, the light colored nictitating membrane often moves over the anterior portion of the eye blocking some of the dark pigmentation of the iris. Although the nictitating membrane can be quickly raised and lowered, *blinking* normally involves the eyelids per se.

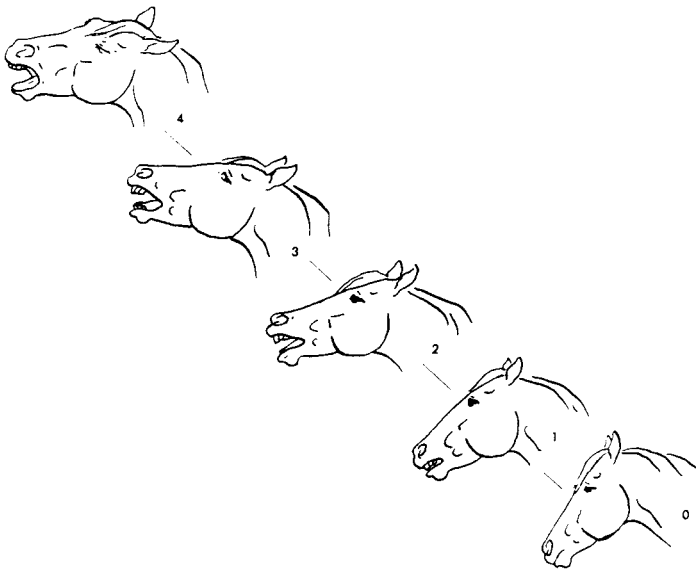


Figure 3.8: Sequence of the yawn. (Adapted from Dark 1975)

Ear movements are versatile and are controlled by the complex interaction of some fifteen auricular muscles (Sisson and Grossman 1953). When the ears are *pricked*, they are forward in a vertical position with their opening directed forward. When the ears are *laid back*, their opening faces posteroventrally and collapse occurs to some degree as they are pressed back against the upper part of the neck. The ears can be rotated individually to varying lateral positions between the fully pricked and the extreme posterior facing positions. The open portion of the each ear rotates approximately 180° through this lateral arc.

The nostril openings can change diameter depending on the physiological and psychological state of the animal. *Flared nostrils* are those maximally dilated.

The attitude of lowered neck, extended head, laid back ears, and forward locomotion is a *head threat*. And when the neck slowly oscillates from side to side this display becomes *snaking*. It is usually exhibited by stallions when attempting to drive or move other horses (i.e., *herding*), whereupon the other horses may show *avoidance-retreat*.

Tail Movements: *Tail switching* as well as *tail depression* (pressing the tail against the perineum) and tail raising occur by the interaction of five muscles. More will be said about motor patterns and postures of the tail and other parts of the body in subsequent chapters.

—Reactive Distances—

Like most animals, horses react to stimuli in a spatially characteristic way. For example, when approached by an intruder, a horse will not necessarily retreat when the intruder is at 100 m but will likely do so when the intruder gets much closer. For an individual horse under a specific test situation, a reactive distance can be quantified (usually measured as linear distance). The response is consistent for that animal under like circumstances and often may be similar to other horses of the same status or background. But when the situation is different, perhaps because of learning by the individual animal or because the stimulus is different (e.g., approaching at a different speed), the linear distance may be noticeably different. A record of an individual over time can reveal how that animal reacts to its environment—what environmental factors influence it, whether it is highly sensitive to certain stimuli and not to others, and whether a certain type of handling is needed or a bad experience has occurred (Waring 1985; 2000). Information on

reactive distances can also form the basis for fuzzy rules used in computer modeling the behavior of equid social groups using adaptive fuzzy systems (Waring et al. 1995; Danhof et al. 1995; Wainer et al. 1995).

If we could measure the neural output from receptors, we could measure the *perceptive distance*—the distance at which a stimulus is first detected by the animal. Instead, what is easier to observe is the *investigative distance*—the distance an animal first shows investigative behavior. The investigation may be subtle; for example, an animal may only rotate an ear or eye in the direction of the stimulus while grazing. The investigative distance may be the same or less than the perceptive distance. As the stimulus object gets closer, at some point the horse will typically elevate its neck, turn the head to face the direction of approach, and inspect the object in an alert manner—this is the *alert distance*.

If the distance between the horse and intruder continues to narrow, at some point the horse will begin to move away—this distance is the *flight distance*. If the intruder is only mildly threatening, the horse may simply show avoidance and maintain that distance (*avoidance distance*) between itself and the stimulus object (often somewhat subtly). However, if the intruder is approaching rapidly or is regarded with great suspicion, the retreat can be direct and more vigorous. When the distance between the retreating horse and the stimulus object has increased sufficiently and retreat is no longer necessary, withdrawal ceases and the horse no longer shows a flight response (this distance is its *withdrawal distance*).

If a horse is unable to retreat (e.g., because it is cornered, tethered, or is a mother protective of her foal), the horse may suddenly show defensive aggression toward an intruder nearby—this is the *defensive distance*. The defensive distance of a horse varies with the situation but is commonly one or two meters. The second reactive distance where aggression is involved is the *strike distance*—the distance where the horse can first achieve aggressive physical contact with another individual.

When a curious animal approaches something and then stops cautiously (before contact is made), that distance is its *approach distance*. The distance can vary with the motivation and experience of the horse, qualitative aspects of the stimulus, space available to retreat, and other factors. Some horses show submissiveness when approached by a companion or handler; the distance where such apprehensive expressions first appear is the *submissive distance*.

When two or more individuals are together, horses typically prefer to have their own personal space. They exhibit this by maintaining an

individual distance between one animal and another; this distance can vary, for example depending on the environmental context, orientation of one animal to another, and the familiarity of the individuals involved. When horses feel threatened, they bunch more closely together than they do when calmly grazing.

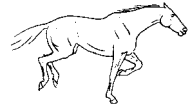
Spacing between social groups also occurs; for example, one horse band will commonly remain spatially distinct from another horse band at a distance called *group distance*. As members of a group move apart while grazing or doing other activity, social companions take action to get closer to one another whenever their separation reaches a certain point (termed the *maximum social distance*). During the neonatal period of horses, the distance between mother and young is typically kept small (sometimes by action of the mare and at other times by effort of the foal); thereafter, the comfort level of their spacing gradually increases as the foal successfully develops and becomes independent, reaching stability at or soon after natural weaning.

Part II



Behavioral Development

4 Ontogeny of Behavior Patterns



The development of behavior begins long before birth and continues well after parturition. For a precocial animal, such as the horse, it is not too surprising to find a newborn has considerable behavioral and motor skills as a neonate.

■ Perinatal Development ■

At birth, a foal exhibits behavior patterns that have developed during the *in utero* period of approximately 340 days. By 90 days, when the fetus is approximately 12 cm, the legs and hooves are well formed. From the third month of gestation onward, fetal movements can be detected by ultrasonic study; these movements become more complex as gestation continues and the fetus matures. Bouts of *in utero* activity and rest occur. The peak of fetal activity occurs about three days prior to parturition and appears to lead to the attainment of the birth posture (Fraser et al. 1975).

In free-roaming herds, births typically occur in late spring. Some foalings do occur at other times of the year—in all seasons. Yet, under most feral conditions foaling is rare during winter. Under management conditions winter births are not as uncommon when parturition can occur in a stall. In fact, to coincide with the custom of recording a horse one year old at the beginning of the next January, some horse associations, for growth advantage in competitive events involving young horses, encourage foaling to occur early in the calendar year—out of phase with natural tendencies.

During parturition the forefeet of the foal appear shortly after the rupture of the chorio-allantoic membrane. At this time, stimulation of the forelimbs may cause some motor response from the foal. But as the body of the foal passes through the maternal pelvis by additional uterine contractions,

reactions by the foal cease, even to painful stimuli, until the hips are delivered (Rossdale 1967a). With delivery past the mare's pelvis, straining by the mare ceases, and the foal is officially born. The hooves are usually pigmented, although temporarily capped by the blunt, soft, unpigmented hoof material (called the perionychium) present throughout much of the gestation period (Pollitt 1995).

Within seconds after the pelvic girdle of the foal leaves the maternal reproductive tract, the foal lifts its head and neck and assumes sternal recumbency. If intact, the amnion is thus ruptured, and breathing can commence unhindered by fetal membranes. The head is unsteady as the foal regulates its upright posture. The eyes are open. The ears remain back or protrude passively to the side. The tail is tucked, covering the perianal region.

Newborn Thoroughbred foals weigh between 38–62 kg (84–137 lb), breathe at a rate of 65 ± 6.5 breaths per minute during the first minute of age, and have a rectal temperature of 37.1° to 38.9°C (98.8°–102.0°F) and a heart rate of approximately 69 beats per minute. During the process of trying to stand, the heart rate can be as high as 200 beats per minute before stabilizing at about 96 (double the adult rate). By one hour of age, the respiration frequency has dropped to 34 breaths per minute (as an adult it will be approximately 12). Body temperature averages about 38°C (100°F) after the first hour in healthy horses (Rossdale 1967b; 1968a; 1969).

In addition to the righting reflex shown in the first moments after birth, the foal's initial movements appear to be a reaction to restraint by fetal membranes and to the hindlegs being not yet free of the maternal reproductive tract. If the mare remains recumbent, crawling movements by the foal, using the anteriorly extended forelegs assisted by motions of the head and neck, cause the neonate to move away from the mare. These locomotor movements drag the foal's hindlimbs free of the mare's vagina and usually cause the umbilical cord to sever as the distance increases (Waring 1970a).

Movements of the foal continue, usually in bouts. Once free from restraint, movements appear to be attempts at getting up. Often at 15 minutes postpartum the foal has begun to raise its sternum off the substrate by pushing with forelegs extended anteriorly, maintaining its forehooves in contact with the substrate. The hindlegs during the initial efforts appear inert; nevertheless, repeated attempts to stand occur. Usually not until after another 30 minutes do the hindlegs finally flex sufficiently to assist in lifting the body free of the ground. If disturbed, the foal and the mare stand sooner than they would otherwise.

Meanwhile the eyes of the foal, accompanied by appropriate head movements, begin to show distinct binocular orientation by 25 minutes of age. Ten minutes after birth, Rossdale (1967a) was able to elicit the pupillary light reflex, and head jerking was inadvertently induced by the flash of photographic bulbs. Usually auditory orientation becomes evident about 40 minutes postpartum when the ears begin to show distinct and independent orientation toward ambient sounds. Even before standing, the foal investigates its immediate surroundings using its eyes, ears, and nose. Periodic tactile and vocal stimulation by the mother begin soon after parturition (Waring 1970a).

Using data on 249 Thoroughbred foals, Rossdale (1967a) concluded the average time taken by neonates to stand was 57 minutes. The data ranged from 15 to 165 minutes, with more foals standing in the 40–60 minute interval than in any other period (Figure 4.1). Among the 127 foals observed by Campitelli et al. (1982), neonatal females first stood at 56.3 minutes whereas males stood at 70.6 minutes, on average. Stop-motion film analysis (Waring 1970a) has shown the initial stance of the foal is unsteady with the legs spread laterally, hindlimbs extended posteriorly, and the forelegs positioned well forward with a slope of nearly 50° . The crest of the neck is held with a slope of about 40° and the dorsal surface of the muzzle at 45° . The foal shifts its neck and feet frequently to maintain its balance.

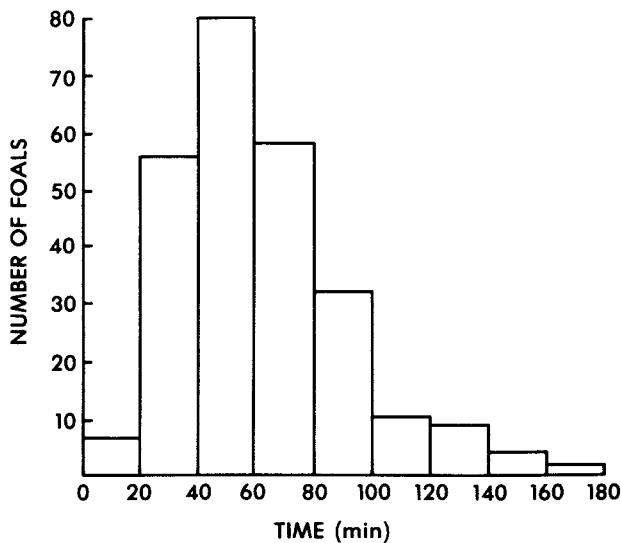


Figure 4.1: Time from birth to first standing for 249 Thoroughbred foals.
(After Rossdale 1967a)

Locomotion forward, laterally, or backward is first accomplished by shuffling motions of the spread legs. These motions soon approximate a walking gait with little leg flexion. During the next hour, the leg flexion and walking pattern are perfected until coordination is achieved and the foal moves along easily.

The sucking reflex can be induced within minutes after birth by objects in contact with the mouth. Tactile stimulation along the anterior half of the head triggers and maintains searching and sucking activity. When sucking has not yet been induced by tactile stimulation, I have observed standing foals as well as those in sternal recumbency exhibit spontaneous sucking motions in mid air 31–60 minutes postpartum. The lips and tongue were characteristically shaped and sucking sounds could be heard; the head was extended and swayed from side to side as the mouth was elevated.

Nosing, sniffing, and licking of nearby objects occurs during the foal's pre-nursing investigations. For example, the mare's forearm, girth, gaskin, and perianal region are thus investigated if contacted.

Successful nursing is dependent upon the mare's willingness to stand motionless and the foal's ability first to stand and then to carry out nipple searching activities. Some mares subtly position themselves in a way that all the foal needs to do is extend its head and begin sucking. Such fortunate foals nurse soon after standing. Often foals inadvertently delay nursing by searching for long periods around the mare's forelegs. In other cases, the restless mare may move away each time the foal probes the apparently tender udder region. In the latter instances, human attendants often intervene to restrain the mare and guide the foal to the milk source. Rosedale (1967a) found that foals born in box stalls nursed between 35–420 minutes following birth. The average was 111 minutes (Figure 4.2). Attendants facilitated some of the initial nursing bouts; yet, other studies of confined and free-ranging horses have found similar results (e.g., see Tyler 1969; Waring 1970a; Boyd 1980).

Once nursing has occurred successfully the first time, the foal returns progressively more easily to the flank area and teats when attempting subsequent nursings. A foal will often suckle from one teat and then the other without changing its position beside the mother. The common stance is with the foal's head tucked between the mare's flank and hindleg, causing the foal to orient posteriorly relative to the mare with one shoulder close to the mother's side. Inter-nursing intervals generally vary between 10 and 90 minutes for the first 24 hours. Drummond et al. (1973) found germ-free foals (fed ad libitum with milk formulated to approximate mare's milk) drank 300–400 ml per feeding.

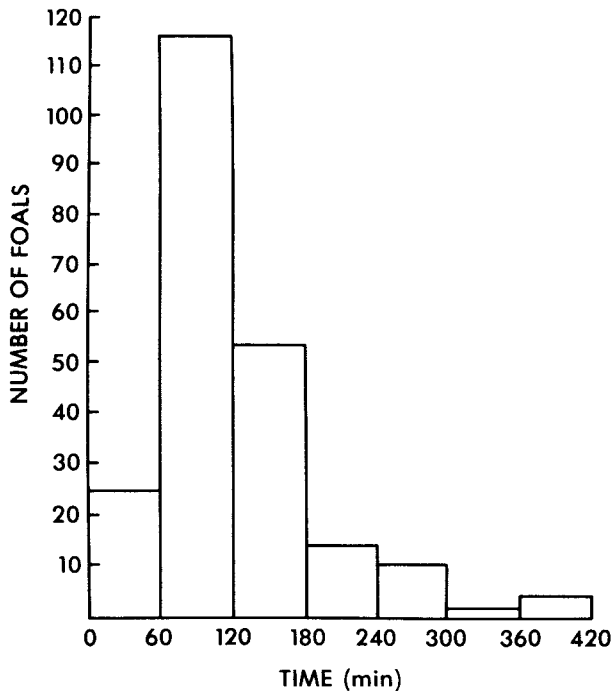


Figure 4.2: The time of first nursing from the mare. Data from 245 foals.
(After Rossdale 1967a)

Defecation may occur prior to one hour of age in foals standing successfully; urination follows a few hours later with posture typical of the sex of the foal. Defecation occurs with the foal spreading the hindlegs, raising the tail 40° or higher above horizontal, and depressing the croup protruding the anal area posteriorly. Straining in an attempt to pass firm pellets is not uncommon.

The first few attempts to lie down often end in rough collapses, although the foal during the second hour postpartum, may try to slowly flex its closely placed legs to go down steadily first to its knees. Unsuccessful attempts to go down are often made at this early age, only to return instead to standing or walking. Resting may eventually be done by fatigued foals while standing. Not until after several tries does a foal lie down with coordination and ease. Having once gotten to its feet unassisted, subsequent standing is usually done readily and with success.

Vocalization is rare from newborn foals. Weak whinnies and squeals may be emitted during the first hour by foals when distressed or restless. Yet it is during the second hour postpartum that the mare and foal overtly respond to each other's sounds. The mare is the more vocal member of the pair.

At the end of one hour of age, the foal shows basic abilities in righting itself, maintaining its posture, investigative behavior, standing and moving about, care-seeking behavior, agonistic withdrawal when restrained, and sometimes other behaviors, such as ingestion, vocalization, and defecation (Figure 4.3).

During the second hour postpartum, the foal begins to follow and remain close to the mother, nuzzles her, and seeks her side upon the approach of others. The foal seems to show concern for the mother when she struggles with discomfort, such as when trying to expel the placenta and fetal membranes. When the mare is down and exhibits discomfort, the foal may circle her restlessly and may whinny loudly following her groans. These behaviors are used as indicators that primary socialization (social imprinting) is occurring at this early age (Waring 1970a; 1970b).

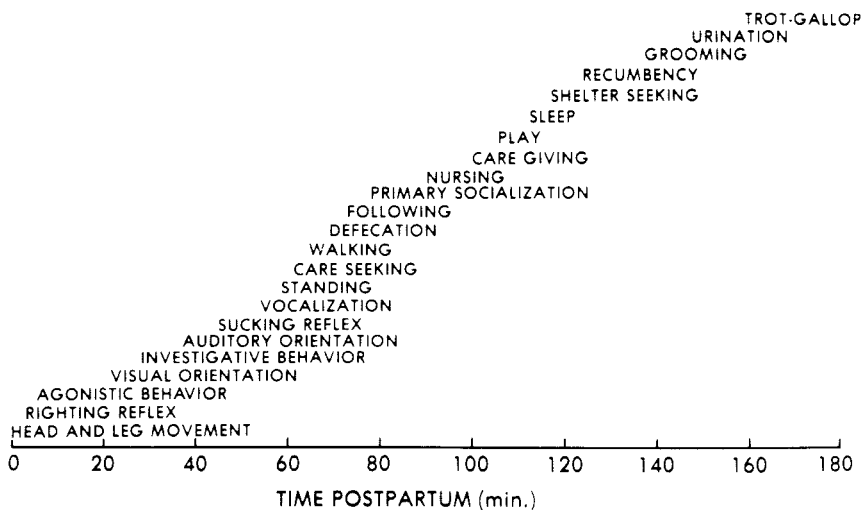


Figure 4.3: Progression in the onset of behavior patterns of neonatal foals.
(Adapted from Waring 1970a and Reed 1980)

Sleep behavior begins as brief naps in the second hour of age and progresses thereafter until deep sleep and drowsiness occupy much of the foal's early life. Sleeping commonly occurs while completely prone or in a relaxed sternal recumbency, but when unable to lie down a foal will stand and doze with eyes mostly closed and neck nearly horizontal. In a study of Welsh ponies, Crowell-Davis (1994) noted foals spent 32 percent of the daylight period in lateral recumbency during their first week.

Fear of new objects begins as early as the end of the second hour of age; but with the security provided by the close proximity of the mother, the foal continues to investigate its surroundings. Foals resist restraint from the early minutes of age; however, learning to adapt to restraint-type handling can occur in these early hours. Foals receiving such early handling separate from their mothers to greater distances and show more self-confidence in exploratory behavior. They also tolerate restraint better when older (Waring 1970b).

At the end of two hours of age, the typical foal has perfected its earlier abilities until it can now walk easily, nurse, follow its mother, vocalize, interact socially with the mother, and seek shelter beside her. Fear and sleep have also appeared.

After several more hours the foal can, in addition, combat insects by nipping at its side and also by moving its tail and legs. It urinates typical of its sex, and it can trot and gallop with ease. It shows brief spells of exuberant play and has begun mouthing various objects, such as hay, grass, twigs, and feces. Some ingestion of these solids may occur. Tyler (1969) once observed a newborn nibble grass for a total of 15 minutes while the mare struggled for 40 minutes to expel the afterbirth. Foals have also been observed to exhibit in the first 24 hours the behavioral patterns of rolling, scratching, rubbing, flehmen, yawn, and snapping (*Unterlegenheitsgebärde*). Swimming, too, is possible. Ron Keiper witnessed a day-old foal swim a four-foot-deep tidal stream to keep up with its mother (Ford and Keiper 1979).

Post-Natal Development

The foal's behavior begins to exhibit greater rhythmicity after the initial perinatal period. Nursing intervals, for example, become more regular; yet like many other behavioral characteristics, nursing too changes with age. During the first week, Tyler (1969) noted the frequency of nursing during the day was approximately four bouts per hour. Thereafter the frequency

decreased; the duration of nursing bouts, however, remained more stable, decreasing only slightly (Figure 4.4). By the sixth week, foals nursed on the average twice per hour; by the fifth month, the frequency decreased to once each hour. Subsequent studies have found similar trends (e.g., see Feist and McCullough 1975; Kusunose and Sawazaki 1984a; Barber and Crowell-Davis 1994). In the Camargue horses observed by Duncan et al. (1984b), colts spent 40 percent more time suckling than fillies during the first 8 weeks; body weight did not differ between sexes, but male foals grazed less and were more active. Berger (1986) observed foals, whose mothers fed on high-quality range, averaged more than a minute longer in suckling duration than foals whose mothers lived on low-quality habitat. Speculation is tempting; however, the amount of milk transferred to a foal during nursing cannot be predicted from nursing duration, nursing frequency, or other behavioral traits typically recorded (Cameron et al. 1999b).

Not just the foal regulates nursing; the mare also encourages or discourages nursing by her activity and posturing. During most of the lactation period the mother rarely limits nursing by using overt aggressive gestures, usually she simply moves away or lifts a hindleg and nudges the foal.

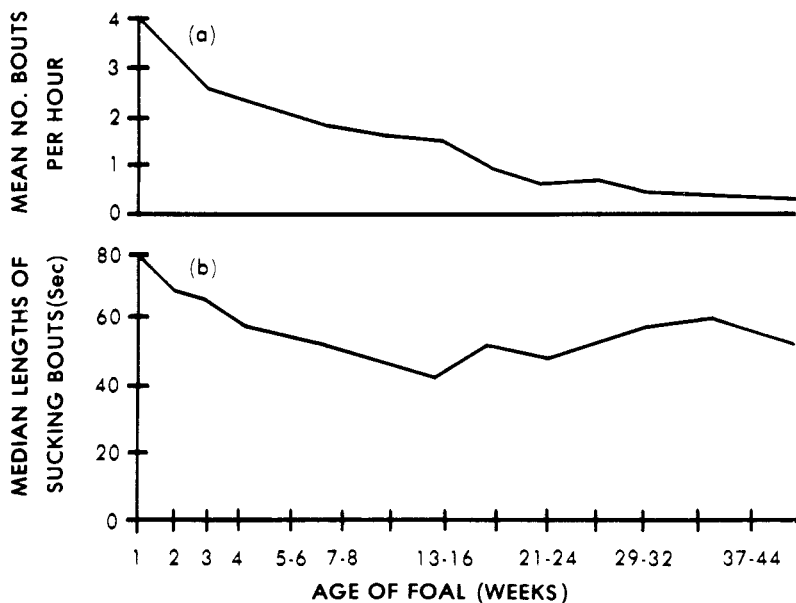


Figure 4.4: Changes in (a) the frequency of nursing and (b) the length of suckling bouts as foals mature. (After Tyler 1969)

However, late in lactation various types of aggression (e.g., threats and bites) become more evident. Duncan et al. (1984b) noted the mare's termination of suckling was especially evident during the early and late stages of the lactation period; whereas, during the middle 60 percent of the lactation period, the foal typically terminated nursing. Some foals in box stalls have been observed to routinely nurse while standing along a particular side of the mare (individually showing preference for either the right or left side); yet in pasture the same mare-foal pairs do not exhibit such position effect (Waring 1978).

Grazing behavior in foals is infrequent during the first week, but time spent grazing increases gradually over the next few months. Albiston and Brain (1986) reported non-orphaned foals as well as a colt orphaned at the age of 100 days showed the same progression of their time-budget toward increased grazing time with reduced time resting as they got older. Tyler (1969) observed a more rapid increase in the time spent grazing after foals reached four months of age (Figure 4.5). She found grazing time was significantly higher in the late afternoon for free-ranging New Forest ponies than for either the early morning or mid-day time period (see Table 4.1).

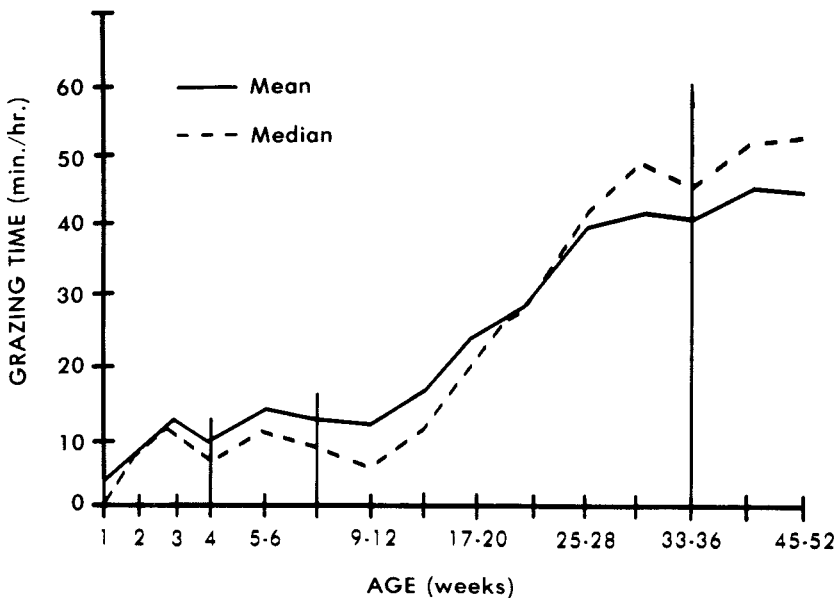


Figure 4.5: Change in the proportion of time foals spend grazing prior to weaning. (After Tyler 1969)

Table 4.1: Minutes per Hour New Forest Pony Foals Were Observed Grazing During Morning, Noon, and Afternoon Periods*

Age (weeks)	0600-1000	1000-1400	1400-1800
1-2	6.5	5.1	7.3
3-4	9.8	11.7	13.2
5-6	15.2	14.4	16.4
7-8	6.7	17.7	13.5
9-12	10.4	13.2	17.0
13-16	13.7	11.3	23.1
17-20	17.5	21.3	32.6
21-24	19.3	20.4	34.9
25-28	25.5	41.1	34.2
29-32	44.3	37.3	41.7

*Data from Tyler 1969

At four months, the foals grazed an average of 16.3 minutes per hour during daylight; by twelve months, grazing occurred an average of 44.4 minutes of each hour of daylight. Similar changes were observed in Camargue foals by Boy and Duncan (1979).

Drinking, other than by nursing, is infrequent by pre-weanlings. Crowell-Davis et al. (1985b) observed drinking by foals 21 times—the youngest, a 3 week old. In their study of Welsh ponies (up to 24 weeks of age), ponds and streams were water sources; the drinking bouts by foals lasted an average of 0.34 min (range: 0.06 to 0.99 min).

During their first four months of age, foals spend considerable time resting, primarily while recumbent (Figure 4.6). Resting tends to be distributed throughout the day. On the open range of the New Forest in England, Tyler (1969) noted that during the first two months, foals were recumbent 70 to 80 percent of their total resting time. Subsequent to three months of age, foals spent less and less time resting; so that by nine months of age, resting by foals was not seen in about half of the hours of observation (Figure 4.7). By then, resting time was minimal during late afternoon. In the Camargue of southern France, Boy and Duncan (1979) reported lateral recumbency decreased from 15 percent in newborn foals to 2.7 percent in nine-month-old pre-weanlings; sternal recumbency decreased from 17.9 percent to 13.2 percent; and resting while standing increased from 8.1 percent to 11.8 percent.

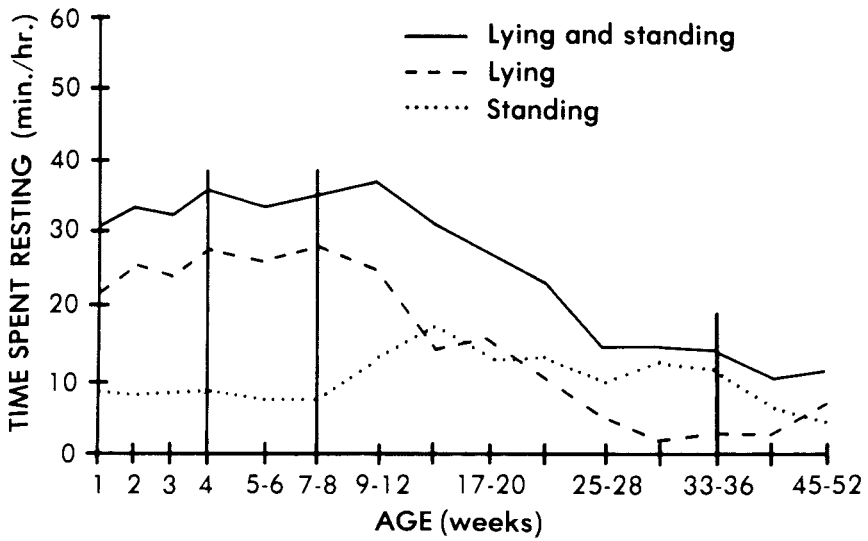


Figure 4.6: Change with age in the time spent resting by foals during daylight hours. (After Tyler 1969)

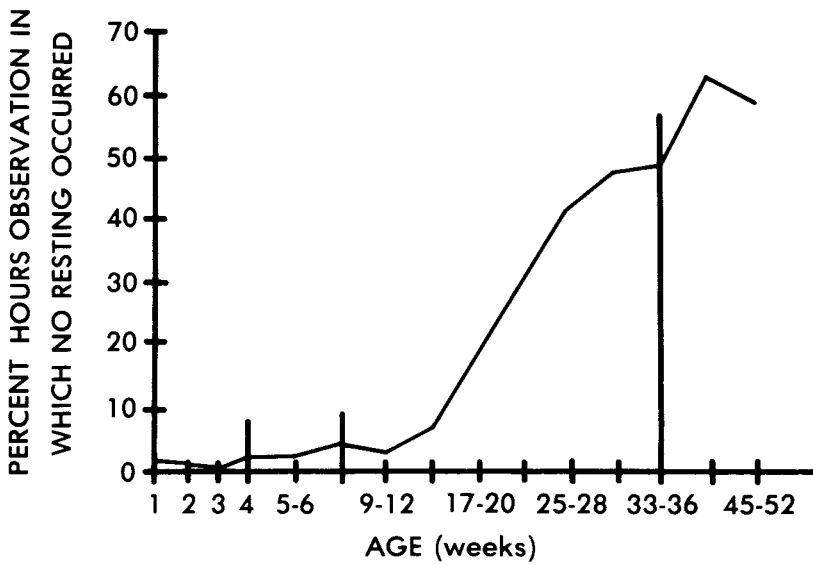


Figure 4.7: Shift with age in the proportion of time foals do not rest during daylight hours. (After Tyler 1969)

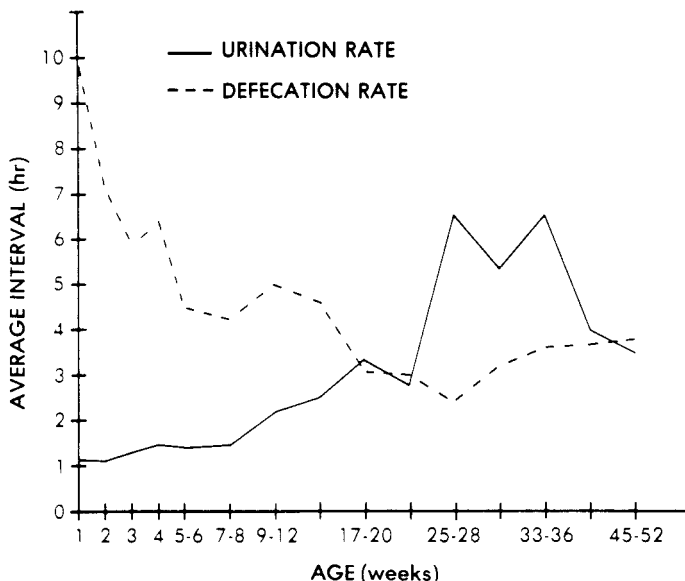


Figure 4.8: Frequency of urination and defecation in foals. (Data from Tyler 1969)

Initially the urination frequency is high in young foals; the defecation rate is just the opposite (Figure 4.8). By seven months, the hourly urination rate gradually shifts to the mother's rate of approximately once every four hours. Defecation proceeds from about once every ten hours during the first week to nearly once every 3 to 4 hours by five months of age (Tyler 1969). Of course, health and diet can influence such rates.

Up to the age of 3 months, coprophagy (eating feces) can be common in foals. Foals observed by Crowell-Davis and Houpt (1985b) showed coprophagy as young as 5 days but gradually diminished by the 19th week. In the first two months, the rate was once per 4.3 hours of observation. Generally the fecal material is fresh and is that of the mother (Francis-Smith and Wood-Gush 1977)—less often that of the foal or other horse. Marinier and Alexander (1995) suggested coprophagia of maternal feces may function to influence food-selective values of the developing foal toward the values of the mother. In most cases, rather than show ingestion, foals briefly manipulate feces with their mouth; others may simply sniff fecal piles. Pawing of the pile may proceed the small amount of coprophagia. Foals rarely defecate onto other feces; however, as foals become older, urination onto feces becomes a rather common response of both colts and fillies (Tyler 1969).

As the skin becomes irritated by biting insects and other causes, foals frequently groom themselves. Scratching of the head and neck with a hind foot as well as nibbling the legs, rump, and back are commonly seen. Coordination develops over several days following birth before balance remains steady. Rubbing, shaking, rolling, and tail switching are also utilized. Foals as young as the first day of age sometimes discover the benefits of rubbing to relieve skin irritation and subsequently spend bouts of up to 15 minutes rubbing selected objects in their environment. Crowell-Davis (1987) monitored self-grooming by pasture-living foals and their mothers for the first 24 weeks of the foal's life (all births were in spring); foals groomed themselves much more often, reaching a peak rate of 12.3 times per hour of observation during weeks 5–8, compared to 1.2–2.2 per hour rate of the mares. In both mares and foals, most self-grooming bouts were brief (usually less than 30 sec); however, the duration of rubbing the hindquarters on inanimate objects averaged closer to one minute.

During its first week, a foal may begin to interact in mutual grooming (allogrooming). The mother or other foals are commonly involved—more rarely, other group members with the exception of the dominant stallion. After four weeks of age, foals spend more and more time mutually grooming with other foals. In the study by Tyler (1969), mutual grooming among foals reached a peak in frequency when foals were 3 to 4 months old. Bouts rarely lasted more than a few minutes. The neck, mane, withers, or forelegs were generally groomed by the pair, using their upper incisors in a rubbing or nibbling action. If bouts continued, the hindquarters received attention. Crowell-Davis et al. (1986) found a peak in foal mutual grooming occurred at about 10 weeks of age with fillies exhibiting higher frequency (1.6 bouts per hour) than colts (0.9 bouts per hour). Colts tended to only allogroom with fillies.

Typically the relationship between the foal and its mother is reinforced over the first day or two, and the distance between the pair remains slight (later, as the foal develops, the close bond gradually relaxes and distance of separation increases). Curious group members, e.g., yearlings, are threatened away by the mare. The innate tendency of the foal to follow large objects solidifies into a strong social attachment between the foal and its mother (often called primary socialization or object imprinting). Rarely, a foal's attachment may be directed toward an inappropriate large object in the environment, such as a tree (see Tyler 1972). In such a case, the mare may abandon the foal; yet, if the foal's fixation is redirected to the mare early enough, a successful mother-foal relationship can eventually develop.

Husbandry and handling practices may greatly affect the mare-foal relationship and the social development of the foal. To the extreme, a foal could be raised on a mechanical milk dispenser isolated from all other organisms, or a foal could be raised in isolation from other horses with only human attention and social contact. Grzimek (1949a) reared a foal under the latter conditions during the foal's first two months. When first confronted with other horses at 64 days of age, the foal exhibited fear, actively avoided the other horses, and attempted to remain with human handlers. The foal did not view horses as conspecifics. A similar defect of normal social behavior has been seen with isolation-reared foals with milk dispensed mechanically (Williams 1974).

Most owners do not desire their horses to be completely human oriented, but the other extreme where a horse fears human contact is also seldom desired. A middle ground is usually sought. Some of my early work with foals (1966–1974) was directed at developing human-socialized animals that also maintained normal social development with the mother and eventually with other horses. We began by utilizing a handling routine developed by Gertrude Hendrix (see Marwick 1967) which commenced as soon as the foal went down subsequent to its first nursing. It soon became apparent to me that primary socialization to the mother was beginning earlier than our first handling routine and that in order to achieve concomitant socialization to humans, our efforts would need to commence sooner. We varied treatments between foals; some received no human exposure, others received active handling and fondling in their first hour or two after parturition, others received passive exposure to humans by a person quietly sitting in the foaling stall, and still others were exposed to a human mannequin standing in their stall. We concluded from this work that primary social attachment in horses is dependent not only upon initial exposure during the early sensitive period but upon propinquity over time. Continued association maintains and strengthens the bond. It typically occurs between the foal and mother. If human socialization commences through handling in the sensitive period for primary socialization, this social attachment will fade when direct human interaction is subsequently rare compared to interactions with a more constant companion, such as the mother.

The foal-mare relationship is maintained, even with human handling, provided the pair is not separated for prolonged periods. I have isolated neonatal foals from 5 to 70 minutes of age with no permanent disruption of the relationship between mother and young. When illness strikes the mare or the neonate, such as the convulsive syndrome of foals (Rossdale 1968b), the pair bond may appear disrupted; yet when the afflicted pair is kept

together, development of the relationship usually proceeds satisfactorily if health can soon be restored. In a young foal as well as a mare who has recently given birth, the drive to establish an intimate mother-young relationship is prolonged beyond the first hour or two until satisfied by a successful pairing.

Successful early bonding appears important in the occasional fostering cases that have succeeded with foals, some as old as 3 months of age (Rossdale 1968b; Tyler 1969). In such cases, mares who have recently lost their own foal can be induced to accept recently orphaned foals. The foals too are receptive once a social void exists in their life.

Early-handled foals when compared to unhandled foals show more exploratory behavior and attenuate fear responses more readily. They move away from their mothers more readily and to greater distances when first turned outdoors, approach other organisms, and in general show more self-confidence. Such activities cause the mother to spend more time following her foal and herding it away from contacts with others. By contrast, unhandled foals are reluctant to leave the side of their mother during their initial exposure outdoors. Therefore, compared to unhandled foals, early-handled foals can be subject to dangers resulting from their zealous curiosity and lack of caution (Waring 1970b; 1972).

The intimate two-way bond that normally develops between the neonate and its mother gradually changes with the foal's increasing age. The widening of the distance between the pair is one indication of the relaxation of the intimate relationship. In the first week, free-ranging foals with normal early experience and no human socialization spend more than 90 percent of their time within less than 5m of the mare (Tyler 1969; Crowell-Davis 1986). By the fifth month they spend about half their time in such close proximity; and by the eighth month, foals are within 5m of the mother only about 20 percent of the day (Tyler 1969).

As the relationship between mother and foal changes, the foal proceeds to develop a relationship with another foal or with a yearling. Progressively more time is spent with the new companion. In a sibling foal-yearling relationship, the foal's independence generally progresses more rapidly than if the foal were associated only with the mother. And the yearling sibling may remain in closer proximity to the mother than it would otherwise, because of its association with the foal. The relationship between mother and offspring, although never as intimate as when the foal was small, is normally maintained to some extent into the offspring's adulthood. Offspring, especially, exhibit periodic interest in grooming and associating with their mother.

The pattern of play behavior also changes with age and companionship. Beginning in its first day, the neonate exhibits periods of exaggerated and often incomplete motor patterns that are considered play activities. Play behavior of foals may contain components of locomotor, agonistic, sexual, ingestive, grooming, and other behavior patterns. Exaggerated withdrawal and approach (e.g., galloping play) can be seen within a few hours after parturition. Biting and nipping at the mare's legs, tail, and other parts of the body are also characteristic of the foal's early play. Initially the mother is the focus of the foal's play behavior, or else solitary play occurs; but as the foal establishes new social relationships, play focuses increasingly on the new foal or yearling companions. Peer relationships thus develop.

Vocalizations and expressive movements are observed in young foals, but no specific ontogenetic pattern has been recognized. Nevertheless, one expressive movement called snapping or *Unterlegenheitsgebärde* is characteristic of young horses, apparently as an overt expression of the animal's anxiety. The behavior pattern consists primarily of vertical jaw movement while the lips mostly cover the teeth and the corners of the mouth are drawn back. The display is relatively silent. The expression occurs when the immature horse appears fearful, e.g., as it approaches or is approached by another horse or large object, when aggression has been directed at the youngster or has occurred nearby, or when the mother is engaged in sexual behavior with a stallion. Table 4.2 shows the variation Tyler (1969) observed in the frequency of snapping as well as the recipients of the display as age increased; she noted snapping rarely occurred after the second year of age. No difference in frequency of snapping has been found between colt and filly foals; however, colts snap more to stallions (Crowell-Davis et al. 1985a). Williams (1974) noted that foals reared on a milk dispensing machine and isolated from other horses showed snapping at the approach of strange humans but not toward familiar ones. The frequency toward humans was noticeably higher in such foals than in foals reared from the beginning with their dam or with other orphan foals.

Sexual behavior develops gradually in young horses. Mounting behavior can be exhibited by both colts and fillies during their first to fourth week of age. Mounting is more frequently exhibited by colts, and subsequent to four weeks it is exclusively a male characteristic. At first, foals incorrectly orient along the side or neck of the recipient (usually the mother) as mounts are attempted. However, even before the end of the first week, it is unusual for a foal to mount incorrectly. Neither penile erection nor pelvic thrusts occur during these early mounts.

Table 4.2: Total Number of Snapping (Unterlegenheitsgebärde) Responses Exhibited by Female Ponies up to Four Years of Age

Adult Initiator	Recipient of Responses				Total
	Adult Foal	Yearling	Female	Male	
Females					
Foal	5	25	92	25	147
Yearling*		1	42	38	81
2 year old			7	6	13
3 year old			5	6	11
4 year old					0
Total	5	26	146	75	252

*In this study, twice as many filly foals were present as were filly yearlings. (Data from Tyler 1969)

By two months of age, colts can be seen with full erections as they rest or interact with other horses in grooming or play. They may investigate the urine and genital region of estrous mares but usually exhibit no further interest. Tyler (1969) witnessed an exceptional case where a 3-month-old colt briefly mounted a 2-year-old filly in estrus; intromission was unsuccessful because of the colt's small height. As colts reach the age of two, greater attention is given to estrous mares. The age New Forest pony colts first achieved copulation varied in Tyler's study from 15 months to nearly 3 years.

Unlike males, fillies show little sexual behavior until they reach puberty and first exhibit estrus. They then approach males, present to them, and urinate frequently, much like older mares. Fillies can come into estrus as early as their second summer when 14 to 17 months of age, but conception is very low as yearlings. Stallions tend to ignore very young mares (Tyler 1969; Feist 1971). And, although colts may copulate with estrous fillies, their reproductive development is incomplete.

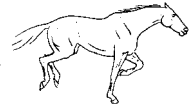
Weaning varies with the foal's situation and that of the mare. Under intensive management, foals are often weaned and separated from their mothers at about six months of age. Yet, unlike the situation at most horse management facilities, in free-ranging herds weaning may occur when foals are almost a year of age or even later. Tyler (1969) observed most New Forest mares weaned their offspring only a few weeks or even just days before the next foal was born. Duncan et al. (1984b) noted that when Camargue mares were pregnant the typical multiparous mare nursed her foal for 35–40 weeks, colts and fillies alike, and weaned them 15 weeks before the next foaling.

Whereas, primiparous mares lactated longer and weaned closer to the next foaling. Among the Granite Range horses studied by Berger (1986), the longest interval between birth and weaning was 19 months. Most foals were weaned between 9 and 12 months; no relationship between weaning age and foal gender, maternal condition, or other factor was detected except for the mare's prior reproductive status. Mares without foals the previous year weaned their offspring at an average of 16 months; by contrast, mares with both a yearling and newborn foal weaned their young at an average of 8.5 months. Whether a dry, non-lactating period exists for a mare between one foal and the next varies from one study and another; it may depend of the nutritional state of the mother (Duncan et al. 1984b).

Weaning can be abrupt; if so, the mare suddenly begins to threaten and avoid her youngster whenever it approaches to nurse. However, Berger (1986) found in the feral horses he observed that weaning was not aggressive or abrupt; it was a gradual process that took several months. Mares which do not give birth to a new foal may show little observable change toward their foal; under these circumstances, nursing may continue through the second summer. In most cases, weaning occurs before the next spring as 2- and 3-year-olds are rarely seen to nurse. Occasionally some mares with new foals allow the previous young to continue its nursing behavior. One offspring may nurse from the side and the other reach the remaining teat from between the mare's hindlegs.

Although foals may be receptive, it is rare that a mare will allow a foal other than her own to nurse. A rare exception was reported by Cameron et al. (1999a), where a free-ranging mother (age 10) and daughter (age 3) shared the care and nursing of a foal. Prior to parturition both mares were judged pregnant by fecal sample assay, but no foaling was observed. The single foal was first discovered when it was approximately three days old. The identity of the natural mother was not known; the foal was mutually bonded to both mares. Seemingly the neonate of one of the mares had not survived. Yet that mare was ready to lactate and receptive to establishing a bond with a newborn foal; the timing was still within the sensitive period. The amicable relationship of the mares contributed to their being together during these events and to not showing mistrust. The mares shared the foal equally and otherwise each devoted normal care and concern for the foal's well-being. The foal suckled both mares alternately 83 percent of the time, remained close to one or the other "mother" without preference, and received total care similar to that of a foal with a single mother.

5 Play



Play behavior seems to have a major role in the behavioral, social, and physiological development of equids. It is common in youngsters and infrequent thereafter. Play provides an opportunity to acquire and test motor and social skills as well as social relationships. In horses, play includes such activities as (i) solitary or group running, often with exaggerated motor patterns, (ii) approach-withdrawal patterns such as alternate chasing, nipping, and pushing as well as (iii) the tossing or manipulating of objects by mouth. Playful activities have components seen in other behavioral patterns; yet, the lack of seriousness, non-threatening facial expression and ear position, and incomplete motor sequences usually make play distinctive. Crowell-Davis et al. (1987) found fillies and colts from birth to 24 weeks of age played with equal frequency.

Although play is characteristic of young horses, mature animals also occasionally play. Feist (1971), however, noticed dominant males of feral bands usually curtailed vigorous locomotor and social play occurring among adult members of their social unit. But such stallions occasionally play fight (e.g., utilizing nipping, rearing, and dancing) with males of bachelor groups (Berger 1986).

With the exception of play between foals, locomotor and social play are normally restricted to horses within the same social group or with close kin. Occasionally foals from different social groups interact in playful activities while their bands are nearby. Play is greatly reduced during periods of extreme ambient temperatures, food scarcity, and most other occasions of physical and physiological hardship.

Solitary Play

Play activities that occur without an interaction with other organisms can be considered solitary play. In horses, solitary play activity is primarily either a type of locomotor play or some form of manipulative play.

Within a few hours of birth, foals have typically begun vigorous locomotor play (Figure 5.1a). They move in a frisky manner to and from their mother or move in small circles exhibiting galloping, swerving, bucking, jumping, striking, and kicking. Similar activities are seen in Przewalski foals (Dobroruka 1961). The movements are initially limited to within a few meters of the mother or some other center of the foal's early environment. These exuberant bouts of playful activity can last a few seconds or up to several minutes before the foal again becomes more quiescent. Play provides most of the vigorous exercise in foal development, at least in the first six weeks (Fagen and George 1977). In a study of Welsh ponies by Crowell-Davis et al. (1987), running alone was the predominant form of play in the first four weeks of age, constituting 77 percent of play for fillies and 41 percent for colts. During weeks 5–8, playful solitary running declined to 30 percent of all play by fillies and 12 percent for colts.

As a foal develops, the distance covered during locomotor play increases. If social contacts are feasible, other young horses increasingly become play companions and solitary play becomes increasingly uncommon.

Manipulative play appears early in the behavioral development of foals and can be seen occasionally in adult horses. Foals as young as two hours of age can be seen periodically nibbling, biting, or pulling at objects in their environment. Sometimes they lift the item, but often their exaggerated movements are an incomplete sequence. After brief contact with the object, the foal shifts to other motor patterns. Approach-withdrawal movements often accompany the playful biting. Pawing of the object and carrying with the mouth may also occur. Crowell-Davis et al. (1987) found object play constituted 7 percent of all foal play behavior from birth to 24 weeks.

Horses, especially stabled animals, can occasionally be observed picking up sticks, boards, rags, pieces of paper, buckets, and other objects and swinging or tossing them. These individuals usually repeat the act several times in one bout. In some cases, the objects appear to be maneuvered toward other horses in the vicinity (Figure 5.1b).

Some stabled horses are notorious for their ability to manipulate electric light switches, door latches, and other devices within their reach. Such activities commonly appear to be solitary play (perhaps a form of entertainment for a bored animal) much to the chagrin of horse owners.

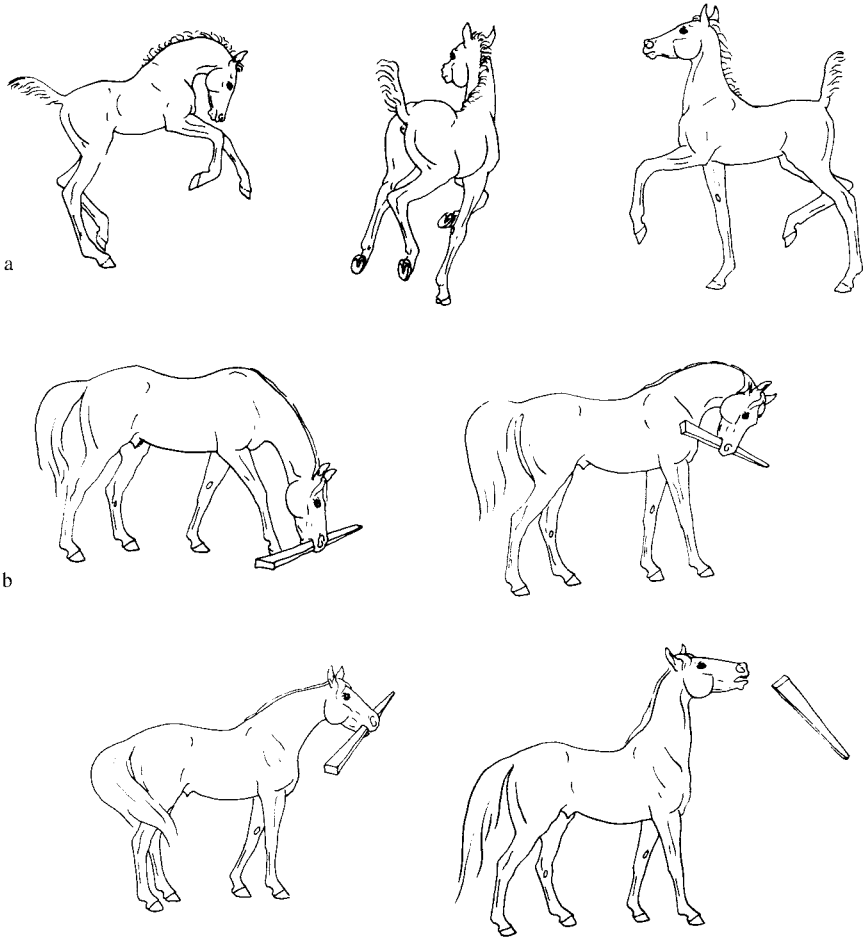


Figure 5.1: Examples of solitary play in horses: (a) locomotor play of a foal, (b) manipulative play of an adult gelding.

Many find motorized barn doors have been opened, a light switch has been activated, or a horse has opened its stall door and has been inspecting the barn.

Play Between Foals and Their Mothers

Play between a young foal and its mother is usually a situation where the mother quietly endures the playful activities of the foal. The mother in such interactions tolerates the nibbling, biting, pawing, kicking, and other antics

of her offspring and seldom exhibits play behavior herself. Yet the mother is typically the focus of the neonate's play.

Within a few hours of birth, foals show an interest in nibbling and poking parts of their mother's body. Neonates can be seen to playfully bite at the legs and sides of their mother. They pull and chew on the mother's mane and tail. Bouts of exuberant galloping occur around as well as to and from the mare. At times a foal in its enthusiasm may strike, kick, or mount the mother or even attempt to jump her while she is recumbent. Crowell-Davis et al. (1987) reported Welsh pony colts (birth to 24 weeks of age) directed 12 percent of all their play toward an adult, whereas fillies did so only 5 percent of all their play bouts.

Although the mother is initially the center of the foal's play behavior, in time the focus of play shifts to peer companionship (Figure 5.2). Tyler (1969) found the percentage of hours of observation where foals played with their mothers or on their own decreased from 56 percent in the week postpartum to only 7.4 percent in the seventh and eighth weeks. Conversely, play with other foals or with yearlings were seen to steadily increase over the same period.

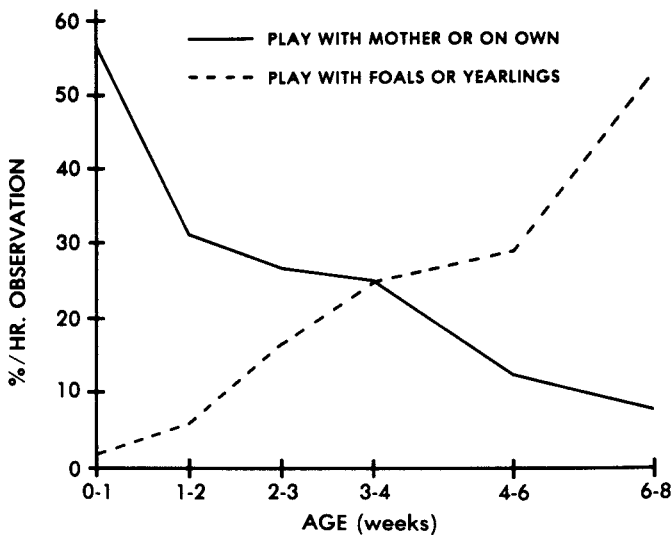


Figure 5.2: Play activity of foals and their choice of play partners during the first eight weeks postpartum. (After Tyler 1969)

By the time foals are about two weeks of age, the exuberant and sometimes rough biting of the foal toward the mare becomes more gentle, and the mare may begin to respond with nibbling of the foal's body. A bout of mutual grooming may ensue (see Tyler 1969; Crowell-Davis et al. 1987).

Play Between Foals and Other Young

On open range, few interactions occur between foals or between foals and older immatures until after two weeks of age. Initial interactions are usually visual investigations, and eventually the animals touch the other's muzzle before swiftly returning to their mother's side. In 158 hours of observation of second-week-old foals, Tyler (1969) found play or related interactions with foals or yearlings occurred in only 6.3 percent of the hours.

After the third week, playful interactions between foals and other young horses become more common. Approach, sniffing, touching, nibbling, grooming, threatening, kicking, withdrawal, and exuberant galloping with bucking and rearing were among the types of activities. Some foals pawed repeatedly at other foals until they stood and became play companions (Tyler 1969).

During the first month of age, the difference in play behavior between fillies and colts is relatively minor, except in mounting frequency. Young colts mount their mothers or peers more often than do fillies. For example, Tyler (1969) recorded colts in their first month mounted approximately once every 5 hours of observation, whereas fillies mounted only once in 37 hours.

Subsequent to the first month of age, play of colts differs markedly from that of fillies. Colts as pairs spend long periods play fighting (Tyler 1969). Such aggressive play occurs between colts of similar age and also between foals and yearlings. Pairing typically occurs, and thereafter the partners seldom interact directly with other colts except in chasing.

Occasionally as foals, a colt and filly in the same social unit will become play and mutual grooming companions. Each shows a preference to interact with the other and for most activities they ignore other peers. Play fighting is evident in such pairs but is usually not as rough as between two colts or between adult males pastured together (Figure 5.3).

In play fighting, each individual attempts to bite the head, neck, and legs of his opponent and push the opponent off balance. They rear and strike at each other and bite at the forelegs often causing the opponent to drop to its knees. They also may bite at the other's hindlegs, causing circling to occur. Effusive galloping with chasing, rump biting, and kicking may occur before another bout of head-to-head interactions.

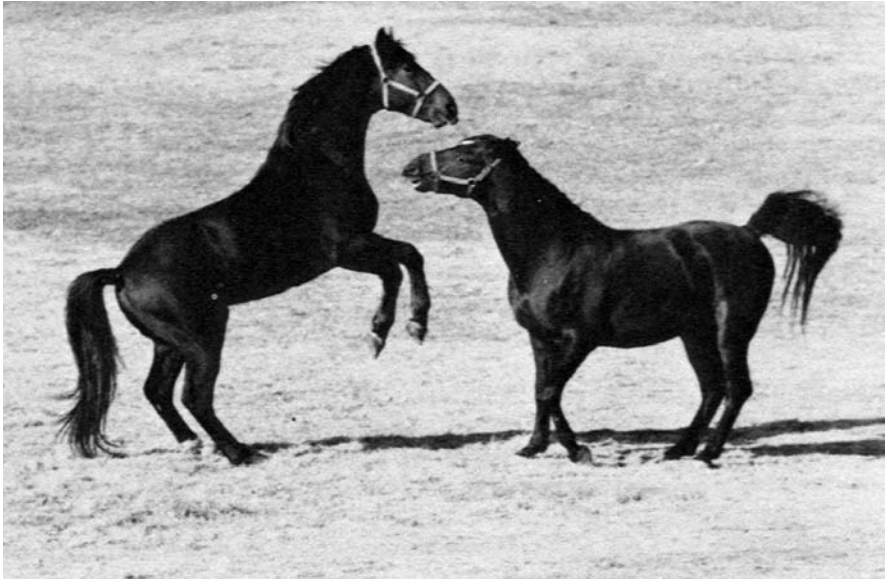


Figure 5.3: Play fighting among males.

Although rough, the play fights are not vicious. In play fighting among Camargue horses, Wells and Goldschmidt-Rothschild (1979) noted that hindquarter threats occurred considerably more often than head threats. As play bouts ended, they noticed a tendency for the subordinate horse to give the last rear threat and the dominant partner to be the last individual to be the chaser.

Interactive pairs frequently exhibit mutual grooming between bouts of aggressive play. In 28 percent of the play bouts among foals observed by Schoen et al. (1976), the bouts were interrupted by both foals exhibiting a head and facial display that resembled flehmen with the ears laid back.

Male foals periodically approach female foals for mutual grooming. Nibbling and grooming may ensue. Yet, whenever the colts begin to get rough and invite play fighting or mount, the female foals typically threaten them and try to avoid their biting and playful mounting. The fillies lay back their ears, bite, and kick.

Playful interactions between fillies are relatively uncommon compared to similar interactions between colts or between colts and fillies. Perhaps, as Tyler (1969) has suggested, it may be the precocious sexual nature of colts that leads to more interactive play when males are involved. Sexual

elements are evident in play interactions between colts and fillies, where the male nibbles the hindlegs and rump of the filly and attempts mounting. Of the 423 playful interactions Tyler observed between free-ranging foals, half involved a colt and a filly, 34 percent involved two colts, and only 16 percent involved two fillies.

Play between fillies is mostly locomotor play, where one filly approaches or moves away from another in a frisky manner using exaggerated movements or they gallop side by side. Chases occasionally occur. Mounting is infrequent. Mutual grooming is the common form of interaction between fillies.

Play Between Young and Adult Horses

Play between foals and adult mares other than their own mother is rare. Most mares threaten away foals that are not their own. Yet siblings and young mares are more tolerant of the playful biting and rearing of foals. They often passively allow foals to play just as the foal's mother tolerates the playful antics of her young.

Colts occasionally show particular interest in young mares and exhibit mounting and sexual interest. Under these circumstances, especially when the mare is in estrus, the colt's behavior no longer appears to be play but true sexual behavior. Tyler (1969) observed a 3-month-old colt show such behavior to a receptive 2-year-old mare. Although intromission was attempted, it was not successful.

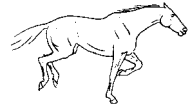
Stallions and geldings are submissively approached by young horses and often tolerate their playful behavior when focused on them. Usually the snapping display is exhibited by the youngster during the approach. The young horse may be allowed to nibble the male's legs and tail or to nuzzle the adult's head or penis sheath. Tyler (1969) noted that 76 percent of such interactions involved young colts; 24 percent involved fillies. When stallions threatened approaching foals, the foals exhibited further snapping or withdrew. Rolling over to dorsal recumbency with legs uppermost was an additional form of submissiveness observed in Camargue foals (Riley, cited by Tyler 1969).

Male foals and yearlings occasionally play fight with adult males who gently frolic with the youngsters. The stallion often ends such activities by walking away. The colt may follow the stallion inviting renewed play by rearing and pulling at the adult's mane (Tyler 1969). In the feral horses

observed by Berger (1986), stallions of family bands seldom played with sons prior to their dispersal from the natal band; yet, when encounters occurred later, stallions were much more likely to play fight with bachelor sons than with non-sons.

Another type of play that is often seen among horses of all ages is the exuberant locomotor activity that occurs prior, during, or soon after a refreshing storm or upon release from confinement. As one horse begins the playful frolicking, companions tend to join the activity. Galloping, rearing, kicking, circling, and other vigorous exercise thus briefly occur before the group returns to more quiescent activities.

6 Investigative Behavior



Investigative behavior facilitates the behavioral development of horses by exposing the animal to new objects, environmental situations, and experiences. It permits the horse to become aware of its environment, not only to avoid hazards but also to learn traits important for its various biological activities. For example, through investigative behavior the animal finds potential danger, food and water, social companions, comfortable resting sites, and pathways. Throughout much of each day, horses exhibit investigative behavior, often while in other types of activity.

By the end of the first half hour postpartum, foals frequently exhibit visual investigation of their surroundings using monocular as well as binocular vision. While still in sternal recumbency, the foal rotates its head and eyes looking around and often fixes its gaze on nearby objects. During the second half hour following birth, the ears of the foal begin to independently rotate to investigate environmental sounds. By this time olfactory, tactile, and possibly gustatory senses have also commenced and are used in the pre-nursing investigative activity of the foal. Once the foal is standing, it moves cautiously nosing, sniffing, and licking objects in its immediate vicinity. Objects at or just above head height are especially explored, such as the mare's forearm, girth, flank, gaskin, and perigenital region as well as tree trunks or stall walls. At this stage, contact along the dorsal part of the muzzle induces the sucking reflex, and the foal appears highly motivated to nurse.

Once the foal has successfully nursed, the objective of most of its subsequent investigative behavior seems more directed at environmental awareness than nursing. The foal investigates its mother's body and the surroundings. It may nibble grass, straw, or fecal material. Each new object in the immediate vicinity is visually, auditorily, tactilely, olfactorily, and

sometimes gustatorily investigated by extending the head, muzzle, and occasionally the tongue. Movements are generally slow and jerky.

As the foal grows and as positive experiences accumulate, the foal's realm of exploration also increases. Negative experiences, where the foal has been hurt or frightened, cause the foal to be hesitant to experience similar events, and investigative activity may be temporarily inhibited. Yet, with each favorable experience, a foal seems eager to explore new aspects of its environment.

The mother usually limits the foal's early social contacts and range of exploration. Once the foal commences peer play activities, the opportunity for furthering environmental exploration and broadening its experiences are greater. Foals which experience neonatal handling and halter training tend to exhibit far greater exploratory interest and confidence than their unhandled neonatal peers (Waring 1972).

Throughout their lifetime horses continue to become alert to new objects that appear in their environment. Also, new sounds as well as odors are, at least momentarily, investigated. A horse may orient its head in the direction of the stimulus, whereby the ears and eyes are directed forward. If the stimulus is at a distance, the neck is usually raised, elevating the head. If the stimulus is nearby, the head may be flexed in a collected position for visual scrutiny, or the head may be extended and the neck lowered enabling the horse to smell and possibly touch the object. Caution often characterizes the horse's investigation.

Investigative activity can occur without the horse orienting its head directly toward the stimulus source. For example, stimulation from one side of the horse may only cause the eye and ear on that side to rotate and investigate. If minor stimulation is behind the horse, the ears and eyes typically rotate in that direction without the head or body becoming reoriented (Figure 6.1). The more suspicious the stimulus the more the horse tends to orient its head and body toward the stimulation. Alertness by one member of a group often induces similar behavior in other group members.

Horses continue to investigate new objects, intruders, sounds, and odors until they appear to have determined if the stimulus requires additional action, such as flight or some social interaction. In most cases, the initially attentive horse returns to its previous activity subsequent to the brief investigation of the stimulus. Often the investigative response is only a subtle eye turn or ear movement. At other times, especially with novel stimuli, the

alertness and investigative response of the horse is overt and unmistakable (Figure 6.2).

If new objects in the environment do not induce flight, they are generally investigated at close range, often by circling the object. The distance they cease their approach and remain separated from the stimulus object is the approach distance. The distance reflects the horse's degree of apprehension. If a stimulus object approaches a horse, avoidance by the horse soon becomes evident; the distance is again dependent on the horse's degree of foreboding. Zeeb (1963) found that the Dulmen horses he observed would closely approach and investigate a motionless human, but they maintained a distance of 3 to 5 m when the person walked near them. The horses withdrew and would not approach a person moving in the manner of a quadruped with hands and feet contacting the ground.



Figure 6.1: Subtle visual investigative response of a horse toward photographer while continuing to graze. (Photo courtesy of R.R. Keiper)



Figure 6.2: Overt alertness and investigative responses of horses.

Excrement of other horses is frequently investigated by young and adult horses of both sexes. The neck is lowered and head extended permitting sniffing of the site and sometimes direct contact. Sometimes a flehmen

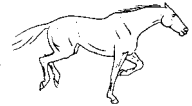
response is given where the head elevates and extends while the anterior portion of the upper lip curls dorsally. Following the investigation of fresh feces and urine, the investigating horse may move over the site and add its own excrement to the site before departing (Feist and McCullough 1976).

When one horse directly investigates another horse, it often approaches with neck elevated (sometimes even arched) while head, eyes, and ears orient toward the recipient. At other times, the investigating horse circuitously approaches utilizing monocular vision. If both horses participate, naso-nasal contact is common, accompanied by sniffing and audible exhalation. Generally other regions of the body are then investigated, such as the head and neck. If only one individual is motivated to investigate, it may concentrate on the flank or perianal region of the other horse. If neither horse becomes aggressive, they often remain near each other until distracted.

Horses exhibit similar investigative and approach behavior toward life-like models of horses and full-sized two-dimensional horse sketches (Grzimek 1943a). The more such test objects deviate from being horse-like in body form, the less horses respond as if the objects were conspecifics.

When a horse is in an approach-withdrawal situation, fear can prevent or impede close investigation. Avoidance is typical. Thus an anxious horse may be repelled by slight or even imaginary barriers, such as a pool of water or an open doorway; whereas, when calm the same horse may approach, investigate, and proceed without incidence.

7 Learning and Memory



Learning is fundamental to the survival of young horses as well as adults. Although a horse has some innate abilities, those traits alone will not suffice; it is the adaptive modification and the supplementation of those traits that make an individual successful.

The capacity to learn has been one of the features that made the horse ideal for domestication. Extensive training is possible. And once skills are learned, retention is prolonged. Yet horses vary. Gender differences are not evident regarding learning or memory; yet these traits seem to have a heritable component (cf. Marder and Price 1980; Wolff and Hausberger 1996).

Prior experiences greatly influence the behavior of horses. They are particularly affected by experiences that cause pain or fear. As trainers well know, even one bad experience, such as with new equipment or at a particular location, will result in a horse showing anxiety each time the same or similar situation reappears. In some cases, the memory of the experience seems to last for years. Considerable training is often required to overcome such negative experiences. Positive experiences, on the other hand, facilitate subsequent interactions and learning. As mentioned earlier, neonatal foals that have been extensively handled readily overcome fear responses to new stimuli and show far more independence of the mother as well as greater exploratory tendencies than unhandled foals (Waring 1972).

Although the process of learning may be a continuum, investigators have found it convenient to divide the phenomenon into several categories. The so-called “types” of learning include habituation, sensitization, classical conditioning, instrumental conditioning, latent learning, insightful problem solving, and social learning (e.g., imitation). Sometimes a small window of opportunity may exist where certain traits are readily learned then but not easily before or after, such as in social imprinting. What follows is an

overview of all these features of learning and memory regarding horses (cf. Voith 1986; McCall 1990).

Habituation

The first type of learning evident in newborn foals is habituation. This trait, apparent soon after birth, involves the reduction of a response upon repeated stimulation. A neonate, for example, will soon cease to withdraw from tactile stimulation and will then allow body contact, such as gentle grooming by humans or the mother, without objection. Repeatedly throughout its life a horse habituates to stimuli that are frequent and of no consequence. In this way, the individual adapts to initially frightening noises, objects, and many other stimuli that regularly appear in its environment. Sometimes stimulus generalization occurs where the adaptation is shown even to stimuli that are somewhat similar but not necessarily identical to those encountered before.

Initial training of a horse regardless of its age often involves habituation. The horse must adapt to close human contact, to the apparatus used during training, as well as to features of the training site before training can effectively proceed to other levels of learning. Many trainers begin working with naive horses by first exposing them to stimulations caused by and associated with the trainer. Tactile, auditory, and visual stimuli are repeatedly directed at the horse in a way that fear and aggressive responses become noticeably diminished through habituation.

Classical Conditioning

While a horse generally learns to ignore frequent stimuli that are of little consequence in themselves, the individual also learns that some initially inconsequential stimuli (CS) are regularly associated with stimuli (US) that trigger a response. Subsequently, the horse begins to give its response as soon as the CS appears without the prior dependence of the response on the US. This development of a new stimulus-response association is called classical conditioning. The CS is the conditioned stimulus, and the US is the unconditioned stimulus. In classical conditioning, the horse's response does not necessarily alter the occurrence or sequence of subsequent environmental events.

Examples of classical conditioning in horses are common but little studied. Foals that require periodic medical treatment soon learn a click of their

stall door latch is associated with the human intruder, thus they commence to show a withdrawal response even before the door opens and the intruder appears. Horses in stables also learn pre-feeding sounds and activity; those stimuli then release responses, such as begging with head gestures and sounds, initially occurring only after food itself appeared. During training and handling, horses often learn to anticipate commands and changes in activity because of the associated conditioned stimuli inadvertently given by the handler. Anticipation becomes evident also when environmental events occur at regular intervals, such as at a particular time of day. When the factor of time is paired repeatedly with events, such as the appearance of the caretaker, the horse associates the time with the event and begins to show anticipatory watchfulness.

Instrumental Conditioning

In instrumental conditioning (also known as operant conditioning), the behavior of the horse influences the sequence or occurrence of subsequent events. Typically the horse's response leads to some degree of reward or punishment. Thus a horse learns to respond so as to bring about reward and not punishment. Reinforcement (both positive and negative) increases the probability of the performance of a behavior. Punishment is different; it tends to decrease the frequency of a response. Reward is a form of positive reinforcement; the animal tends to increase or repeat behaviors it did just prior to positive reinforcement. Negative reinforcement is an aversive event that increases the probability the animal will respond to avoid or escape subsequent negative reinforcement. For example, Poplawski and McCall (1989) taught horses to back 1m within 3 seconds after hearing a whistle so as to avoid a bump on the chest by a pole (negative reinforcement); nevertheless, the horses learned when a buzzer sounded to stand stationary for a food reward (positive reinforcement). Whether by trial and error or by the manipulation of a handler, horses learn to respond to commands, to open covered boxes to obtain food, to press a lever to activate a watering device, to distinguish between similar items, and to do or not do various other activities.

The capacity of horses to apply instrumental learning to their daily life can be illustrated by a 23-year-old mare I studied at the University of Munich (Waring 1974). Although the mare often drank and ate in a typical manner, she and two other horses in the barn would occasionally begin a session of hay dunking in water before ingesting the roughage. The mare's trait was to lift the hay from the floor pile by sliding large amounts

up a nearby wall and onto a concrete shelf at the rear of her stall. The hay was pushed along the shelf with her muzzle until it was against a small water basin attached to the rear wall. The mare then took small amounts of hay in her incisor teeth, dunked the hay into the water basin, and chewed. More than one dunking often occurred before the hay was swallowed and the process repeated. With each dunking the pressure plate of the horse-activated watering device was triggered, thus soon water overflow had the shelf, wall, and floor saturated.

The observed hay-moistening behavior was not a stereotyped behavior or done without purpose. Wetting the hay was the motivation. Fresh cut grass was neither moved to the shelf nor dunked in water. Hay soaked for one hour in water and fed to the mare also did not induce the regular dunking trait. Yet as soon as dry hay was present, the mare commenced the routine of dunking the dry material in her water basin an average of 5.1 times per minute as she ate. When the watering device was turned off and no water was available in the basin, the dunking trait waned (extinguished) as shown in Figure 7.1. Recovery of the behavior pattern promptly occurred upon my restoring water flow to the device. To test if the trait was unique to the self-activated watering device I extinguished the response to the water basin, then two buckets containing water were placed in a depression of the shelf. The mare soon began to steadily dunk hay in the buckets (Figure 7.2) and seldom tried the water basin. However, as soon as the horse saw the valve manipulated to restore water flow to the self-watering apparatus, she shifted her hay moistening behavior to the water basin exclusively. Thus, the mare exhibited considerable ability to use knowledge she had acquired through learning.

Stabled horses provide frequent opportunities to witness the operant capabilities of the species. In the horse research barn at Southern Illinois University—Carbondale, covers had to be installed over toggle as well as push-button switches within reach of the dexterous upper lip of certain horses who acquired the ability to activate the switches. Furthermore, double locks have been necessary on some stall doors to dissuade the departure of those individuals who have learned to grasp and lift the original latch with their teeth. Koegel (1954) told about a gelding who periodically removed a bar from his stable door. Egress occurred to join a mare outside the stable.

Oftentimes horses have the ability to gain access to covered food containers by using their mouth, upper lip, or muzzle. In tests with horses, Gardner (1933) found acquisition of a technique to open a covered feed box was rapid and was perfected in 3–4 trials, especially in the 5–14 year age group. In some cases, retention of the learning was still evident 6 to 12 months later.

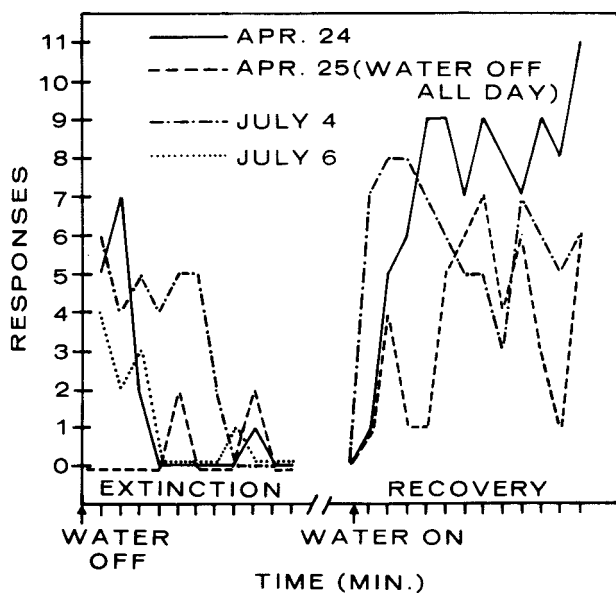


Figure 7.1: Experimental extinction and subsequent recovery of a conditioned response characterized by the horse dunking mouthfuls of hay in the basin of a self-watering device. The response waned when water was no longer present and recovered when the horse saw the water control valve opened. (Waring 1974)

Occasionally horses learn to wield objects at other horses apparently in play; a crude form of tool use. Dark (1972) watched a full-grown gelding repeatedly lift, aim, and toss a wooden pole in the direction of another horse (see Figure 5.1b). Gertrude Hendrix (pers. comm.) similarly observed a yearling gelding repeatedly lift a rubber feed pan and, while holding the pan in his teeth, approach and spank a yearling filly who was trying to graze. The filly eventually became aggressive and ended the companion's game which had recurred on two successive days.

Numerous experimental procedures have been developed to study instrumental learning. These include free-operant conditioning and procedures using discrete trials, such as avoidance learning, mazes, and discrimination learning. Most experiments with learning in horses have used variations of these procedures. Reinforcement, if administered, is either after every correct response (continuous reinforcement = CRF), after several correct responses have been performed (fixed ratio = FR and variable ratio reinforcement = VR), or following the first correct response after

an elapsed period of time (fixed interval = FI and variable interval reinforcement = VI).

Experimentation using a lever-pressing apparatus has been applied to horses. Similar to other animals tested for free-operant responses, Myers and Mesker (1960) found a horse gave relatively stable rates of response when several FR and FI reinforcement schedules were used. Evidence of anticipation appeared with FI schedules. Panel-touching behavior was successfully established in three geldings by Miyashita et al. (1999) using an autoshaping procedure.

Hamilton (1911) studied the trial and error reactions of an 8-year-old gelding presented with four exit doors. In each trial, only one door could be opened; yet seldom would the horse try different doors to find the correct exit. In 86 percent of the responses, the horse focused its effort at one or two locked doors. Williams (1957) noted a similar tendency of horses to persist at one site when confronted with a detour problem (Figure 7.3). Alternate solutions are not readily attempted.

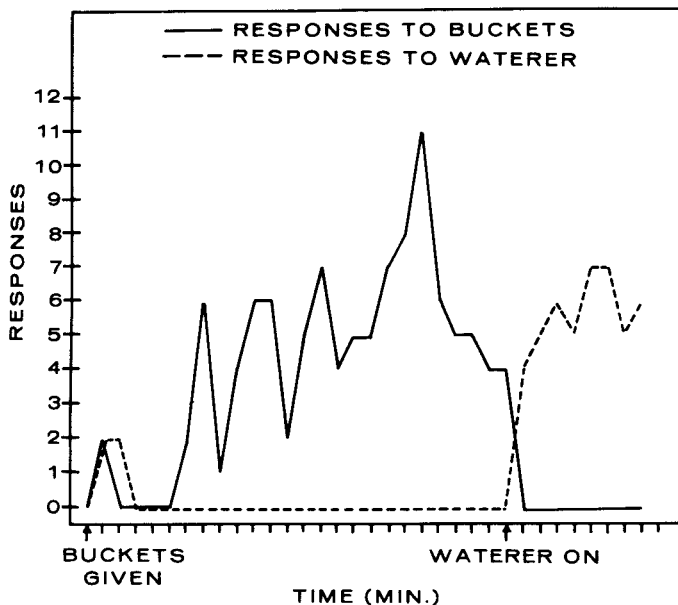


Figure 7.2: Development of hay-dunking responses to a new water source following extinction to a self-watering device, then the total shift to the original source when free choice was provided. (Waring 1974)

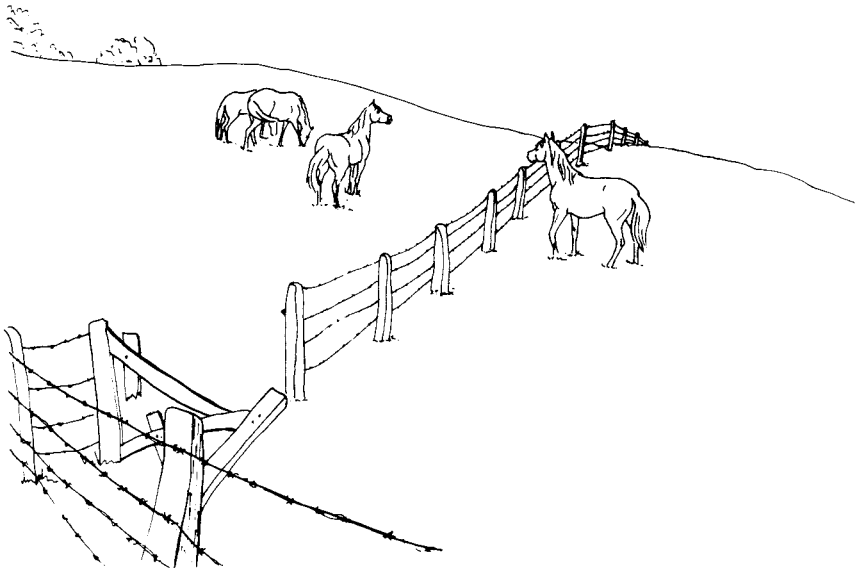


Figure 7.3: Horses tend to persist at one location rather than try alternative solutions to problems requiring a detour.

A modified T-maze was used by Heird et al. (1986a) to study learning in Quarter Horses. Two groups of subjects were tested for 20 consecutive days on either a place or a discrimination task then given a 10-day extinction period before the alternate task was tested for 20 days; the procedure was repeated until each group had experienced each task twice. One group began with the place task; the other group began with the discrimination task. Horses of both groups were tested individually for 20 trials per day or until criterion was reached. For the discrimination tasks, the subjects were presented (at the choice point of the maze) a visual cue positioned nearer the reward side of the maze; the reward side varied randomly between trials. The same T-maze was used for the place tasks but no cue was present; instead, the food reward was placed in one side for a test day, but on the alternate side on successive days. Data showed learning occurred at a faster rate on the discrimination tasks compared to the gradual learning curves observed on place tasks. The subjects learned more rapidly and reached higher levels of performance as the series of tasks progressed. Marinier and Alexander (1994) found individual differences occurred in the rate their

experimental horses learned a maze, but, once the subjects learned, memory of the solution to the maze was long lasting.

McCall et al. (1981) used the Hebb-Williams closed-field maze to study learning abilities in yearling Quarter Horses. The solution of the maze was altered by changing the position of dividers within the closed-field system. Twelve arrangements (problems) were tested. The yearlings were more efficient in solving problems with direct visual solutions. Individual variation was apparent. Often a horse would reach asymptote by the fourth or fifth trial of a problem then spend time investigating the maze in subsequent trials rather than move straight to the goal box, where a food reward was waiting.

A two-component maze also has been used to assess the learning ability of horses. As a subject enters the first compartment of such a maze, it must turn either right or left around a partition to enter the second compartment. One route leads to an exit, the other does not. Kratzer et al. (1977) used the maze in a study of 37 yearling geldings. When a right-side choice was required during five trials, both latency of escape and errors decreased. Then a left-side choice was required of the horses. Latency and errors again decreased, but after three trials these values were still relatively high. The horses tended to still try the right side. Thus, an aversive stimulus (CO_2 fire extinguisher discharge) was presented whenever a horse started to enter the dead-end compartment. Errors subsequently decreased during the remaining three trials, but latency did not. Test subjects fed 10 percent, 13 percent, 16 percent, and 19 percent protein diets did not show consistent differences in learning ability. In other studies using a two-compartment maze as well as a shock-avoidance technique, Haag et al. (1980) found no correlation between dominance rank and learning ability.

Most studies of learning in horses have used a discrimination problem. Gardner (1937a) confronted horses with three covered boxes; the horses learned the box that contained grain was always draped with a black cloth. When the cloth marker was then suspended low in front of the correct box, the average number of errors for 44 subjects doubled compared to trials 11 to 22 of the original paradigm. When the cloth was suspended above the feed box, discrimination errors quadrupled (Gardner 1937b). In another experiment when a 12-quart pail was used as a signal instead of a black cloth, the subjects ($n = 56$) showed similar trends; errors were most frequent when the discrimination signal was suspended above the correct feed box (Gardner 1942).

Nobbe (1974) conditioned a horse to alternately nudge two rectangular polyhedrons (one black and the other white) suspended at nose height from the ceiling and spaced one meter apart. Grain was used for reinforcement. The response was taught (shaped) in two 15-minute sessions over a period of two days. After seven more sessions of the same length and a shift from continuous to fixed ratio schedule of reinforcement (BWB or WBW), the horse was then required to give a BWBW response (FR4 reinforcement schedule) before being rewarded. In the first FR4 session 244 alternated responses were given; 292 occurred in the second FR4 session. Throughout the experiment, the response rate increased steadily even when an interval as much as one week occurred between sessions.

Warren and Warren (1962) required a pair of horses to learn to alternate between two feed boxes (black was on right and the white box was on left) after the horses had previously learned to seek hay from just one of the two boxes. Subsequent trials alternated between the two types of tasks (single versus alternate). Both subjects learned the successive reversal problem quickly. One horse averaged fewer than two errors per reversal over the series of nine tests; the other horse averaged two errors per problem during six reversals. There was a rapid decline in the number of errors made on consecutive reversals. Sappington et al. (1997) found overall poor performance on discrimination reversal tasks in the ten yearling and seven 2-year-olds they studied.

McCall (1989) studied learning abilities with regard to nutritional status (body condition). Malnourished horses were obtained for study and initially scored thin, moderate, or fat; they were then assigned to corresponding treatment groups and rehabilitated before testing with a discrimination learning task. The concentrate ration of the moderate and fat treatment horses was increased proportionately to keep them at the appropriate condition score for their assigned group. The study found treatments did not differ in total trials to first criterion; however, individuals in the fat treatment had higher total error scores than horses on the thin or moderate treatments, probably owing to a lack of motivation.

Fiske and Potter (1979) applied the serial reversal discrimination technique of Warren and Warren (1962) on 26 yearling Quarter Horses. Mean trials (MT) and mean errors (ME) required to achieve criteria were computed for each horse, then a relative learning ability index (LAI) was calculated ($1000/MT/ME$). A single subjective trainability score (1 to 6) was obtained from a trainer. Linear regression analysis revealed a reduction in MT and ME ($P<0.01$) over the 21-day test period indicating learning set

formation. Differences ($P < 0.05$) were evident between sexes for MT and ME. Disruption of mental concentration due to estrus was suspected, at least for several fillies. Significant correlation between trainability score and learning ability measures (MT, ME, LAI) was evident for colts and geldings but not for fillies.

Voith (1975) investigated a spatial reversal problem (where position was relevant, not the stimuli themselves) and a visual reversal problem (where stimuli were important, not their position). Black and white stimuli were used. The horses demonstrated progressive improvement in their ability to learn either type of reversal problem, although visual discrimination reversal problems seemed to be more difficult to learn than spatial.

Pattern discrimination learning has also been studied. Giebel (1958) conditioned a horse, a donkey, and a zebra to discriminate the correct choice in each of 20 pairs of patterns so as to obtain a food reward (Figure 7.4).

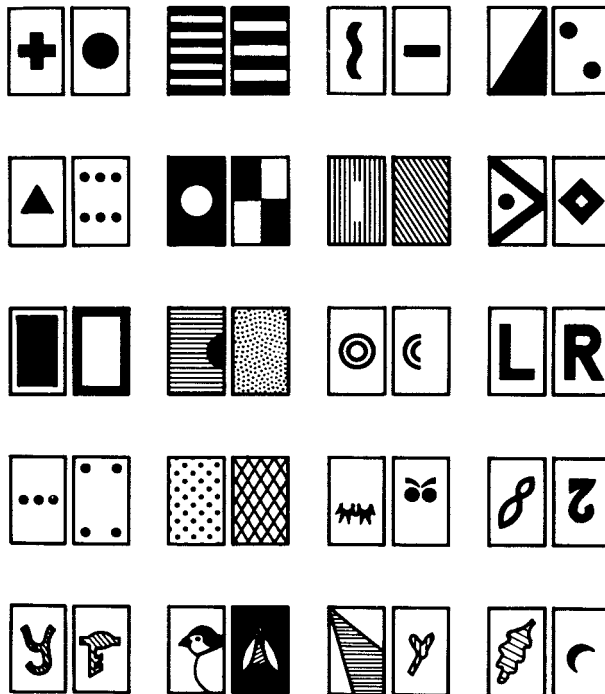


Figure 7.4: Pattern discrimination pairs used in the studies of Giebel (1958), Dixon (1966), and Voith (1975). The left pattern of each pair was the correct choice to obtain a food reward.

The horse learned all 20 pairs, the donkey learned 13, and the zebra learned to discriminate 10 of the pairs. During a memory test at the end of training where each pair reappeared randomly a total of 30 times, the horse gave a perfect performance on four pairs and a performance low of 73 percent on one pattern. Retests at three, six, and twelve months showed virtually no memory loss on at least 19 of the pairs. Dixon (1966) conducted a nearly identical study with a 7-year-old pony gelding and found similar results. Retests at one, three, and six months showed an 11.5 percent loss of learning in the first month but little (3.5 percent) over the next five months. The frequency of correct choices on all 20 pairs at six months was 77 percent.

The learning set phenomenon described by Harlow (1949) seemed to be clearly demonstrated by the pony Dixon (1966) taught to discriminate patterns. The gelding learned how to learn. Successful discrimination of the first pair of patterns required numerous trials, but as the pony learned the game rules (i.e., that one stimulus of each pair led to a reward) fewer errors were made. From the sixth pair through the 20th the horse learned in one or two trials.

Voith (1975) repeated the pattern discrimination experiment, primarily to test for learning set and memory as well as to control for possible cueing by the experimenter. A trend of progressive improvement in learning successive pairs was demonstrated, although not as distinctly as in Dixon's study. In a non-reinforced retest immediately after all 20 pairs were learned, Voith's two mares achieved a 77 percent accuracy. When one mare was retested 12 months later, the performance was sluggish and was no better than chance. Reinforcement did little to improve the performance. Although the horse no longer demonstrated accurate pattern discrimination, it did remember how to work the experimental apparatus.

Whether horses might detect conceptual similarities of stimuli when problem solving was the focus of Hanggi's (1999a) study. In a 2-choice discrimination task, the subjects were taught to select 2-dimensional black patterns with open centers instead of a filled pattern with similar outline. The horses gradually learned the first pair of discriminations (training stimuli). Subsequently, on 15 additional pairs of open-center versus filled stimuli tested, the horses learned with few or no errors; correct responses on novel trials were significantly above chance, suggesting the horses were making their selection on the basis of shared characteristics with the training stimuli and were using categorizational skills in problem solving. The horses studied by Flannery (1997) successfully learned the concept of sameness.

When three choice stimuli were presented to the horses, they were regularly able to select the two stimuli that were the same and avoid the non-matching stimulus, even when the experiment was repeated under a new presentation situation.

Mader and Price (1980) designed their discrimination study so horses had to learn to choose the correct visual stimulus (a checkerboard pattern) from a set of three stimuli. Among the 16 horses compared for their learning score, Quarter Horses learned faster than the Thoroughbreds tested. Learning performance declined with age. No relationship was found between dominance status and learning ability. Suggestive of the learning set phenomenon, learning progressed more rapidly for the second discrimination task than for the first. Although studies and their objectives vary, the learning set phenomenon often is evident in the results of learning studies (e.g., see Heird et al. 1981; 1986a).

Hanggi (1999b) utilized a simultaneous 2-choice pattern discrimination task to test whether horses that learn with one eye are subsequently able to perform correctly when only the other eye is available to see the patterns. The test animals demonstrated high levels of interocular transfer of learning on the four problems tested as well as on the reversal discriminations.

Horses apply learned discriminations in their daily activity, for example, mares identify their own foal (e.g., see Leblanc and Bouissou 1981). While grazing, many horses carefully choose and sort vegetation to obtain mouthfuls of specific plant species. Learning appears to be involved in such traits. Marinier (1980), while investigating selective grazing, found horses could be easily conditioned to avoid one of two equally palatable plant species. Two kinds of plants were repeatedly presented to each experimental horse and mild punishment was administered when a wrong choice was made. Although discrimination was learned, the horses differed in the number of trials needed to achieve success and in the amount of punishment required.

Taste aversion learning was studied by Houpt et al. (1990) to see how well ponies learn to avoid relatively novel foods associated with illness. The subjects were tested in three situations: when illness occurred immediately after consuming the test food, when illness occurred 30 minutes after consuming the food, and when illness was dependent upon eating one of three food types offered simultaneously. Apomorphine hydrochloride was administered intramuscularly to induce illness; in control situations, an equivalent volume of salt solution was administered. Food types tested were corn,

alfalfa pellets, sweet feed, and a complete pelleted feed. The test animals learned to avoid all the feeds except the complete feed when apomorphine injection immediately followed food consumption. Aversion learning was not demonstrated when apomorphine was delayed 30 minutes following consumption. When test feeds were presented with familiar foods (oats and soybean meal), the ponies learned to avoid alfalfa pellets, but not corn—suggesting horses may form aversions more easily to less preferred feeds than to the more palatable.

Popov (1956) reported his experimental horses could discriminate very slight changes in acoustical, visual, and tactile stimuli. Such signals are common in horse training. To test for the ability of horses to respond appropriately upon auditory, visual, and tactile cues, Yeates (1976) constructed a horse-size lever-pressing device. In the box chamber, each of three mares was taught to push a hinged flap to obtain food reward. Each mare learned the task within 1.5 to 2 hours. The horses then had to learn that food reinforcement would only occur when a flap-pushing response was done in the presence of either a yellow light, a coarse-sounding buzzer, or a pulsating tactile stimulus remotely applied at a forerib. By the end of a 21-day period, each mare had an improved performance, yet individual differences were evident. One mare was then left in the chamber continuously under a free-operant situation cued by the visual stimulus only. Her performance in five days had improved from 66.9 percent to 94.4 percent correct responses.

To test whether generalization would occur to a tactile stimulus, Dougherty and Lewis (1993) trained horses to respond to a light tapping stimulus applied to a specific site on their back. The horses did not generalize and subsequently showed a preference to respond to the tactile stimulus at the original site rather than to similar tactile stimuli administered elsewhere on the back.

Whether the early experiences of foals influence their learning ability has been of interest and has received study. Houpt et al. (1982) tested for effects of maternal deprivation on learning by foals, but no effect was found. Orphan foals learned a simple maze equal to mother-reared foals. Heird et al. (1986b) found horses with different degrees of human handling while young all achieved learning by Day 10 as 2-year-olds, but the most-handled group reached a consistently higher percentage of correct responses earlier than the less-handled groups. Mal et al. (1994) also gave foals different degrees of human handling and tested them following weaning at approximately 4.5 months of age; the treatment groups showed no

differences in learning ability or in manageability. Jezierski et al. (1999) found their intensively-handled foals scored better than non-handled foals for manageability and lower heart rate when studied up to 2 years of age. Foals that received intensive handling beginning at age 2 weeks scored better than those receiving intensive handling beginning at 10 months of age. The topic of early human handling will be revisited later (see Behavioral Manipulation).

Often horses are given repeated conditioning trials during training sessions. But how many trials should be given per session for effective learning? To answer such a question, McCall et al. (1993) systematically varied the number of trials per session. They concluded moderate repetition of training activities is needed for efficient learning. In their study based on avoidance learning, 16 trials per session were found most effective (i.e., to minimize the number of sessions to reach criterion).

To achieve learning, training can be frequent or spaced with long inter-trial intervals. Rubin et al. (1980) conducted a study to look at the effect of such temporal distribution of training sessions. Horses were taught to respond in a particular manner upon the presentation of a visual or auditory cue so as to avoid receiving a mild electric shock. Some horses received daily training, a second group had training twice a week, a third group had one training session per week. The horses trained once a week achieved the learning criteria in significantly fewer sessions than subjects trained daily; yet the elapsed time from start of training to completion was greater because training was spread over many weeks. The twice-a-week group learned at a rate intermediate to the other two experimental groups.

In summary, experimentation with instrumental conditioning of horses has shown horses can master numerous discrimination tasks as well as maze and avoidance learning. In some cases, memory can be prolonged. Horses, when provided several potential alternatives at once, tend to concentrate their trial-and-error efforts at only one or two of the alternatives. Habit strength develops rapidly. Individual differences in learning do occur; some breed differences may occur, but more data are needed to confirm those results. Differences between sexes are not consistent, as is the effect of emotionality on learning. Youthful horses, but not necessarily the youngest, perform better in learning tests than older horses. Dominance rank and learning ability are not correlated. Although teaching a horse an entirely new task may be tedious, similar tasks are learned with considerable improvement. Horses learn in fewer trials when the sessions are spaced at intervals rather than concentrated into a short time span.

Latent Learning, Insight, and Social Learning

Latent learning is the association of stimuli or situations without obvious reinforcement or the trait itself being evident at the time of learning. It often results when an animal becomes familiar with its surroundings. For example, features about the geography and many objects in the environment can be learned during exploration; at the time, the individual shows no evidence that it has received positive influence or reinforcement. But later, the individual may apply what it has learned in a way that enhances its survival. Thus a horse new to its range may return straight away at mid-day to the shade of a lone tree it had passed earlier while exploring.

While working with horses, handlers periodically witness that a horse had developed awareness and abilities beyond those being taught or that are exhibited only later after training has ceased. Williams (1957), for example, noted a novice mare she was training to jump showed little progress prior to a severe illness and a 9-month rest. Yet the individual returned to training with awareness and ability noticeably beyond that a learning curve would have predicted had training continued 9 months earlier. The mare had apparently acquired associations with earlier training that had yet to be fully assimilated before the prolonged rest.

Hendrix (1968) witnessed what may have been latent learning and concept formation. One day she had decided to reschool a proper canter to a flighty show horse by using four level stretches of terrain each with a steep hill at the end. The steep slope would hopefully allow her to regain control if the horse broke into a racing gallop. The first two level stretches were negotiated successfully with a walk, trot, walk inserted between the places to canter. As the third flat stretch came into view the horse began to snort, collected its head, and moved in an excited manner. The anticipatory horse showed awareness that at level stretches the command to canter could occur. Another example Hendrix experienced was with a horse that had repeatedly been required to pause at a roadside. The command to proceed across the road was given only when oncoming traffic subsided. One day when the rider thought the way was clear she urged the horse forward, but the horse refused. The horse took heed of an oncoming car and did not proceed until it had passed. The horse seemed to have associated stopping at the edge of the road with oncoming traffic, not simply a whim of the rider.

Insightful problem solving, where an individual uses a combination of two or more learned tasks to solve a new problem, has not been systematically investigated in horses. Again, anecdotal evidence could be cited, such as the relatively intricate schemes some horses devise to rid themselves of

a novice rider. The hay-moistening mare mentioned earlier in this chapter may have been using insight to adapt to the use of buckets when the watering device was turned off. The ability for insight is likely; yet in most daily activities and in most problems encountered, horses show little that can be attributed to insightful problem solving.

Learning assisted by companions is social learning. Tutoring and imitation are examples. By way of example, Glendinning (1977) reported orphan foals did not graze until turned out with older horses. But, Marinier (1980) found trial-and-error was more likely responsible for selective grazing in foals than was imitation. Imitation is sometimes attributed to horses that begin cribbing or weaving. However, experimental evidence is lacking that vices are acquired by imitating others.

Observational learning has received some experimental investigation. In the study by Baer et al. (1983), observer horses were allowed to see other horses correctly performing a discrimination task for 5 days prior to the testing of their learning response to the same task. Small differences between control and observer groups occurred, e.g., errors in the observer group tended to be lower initially ($P < 0.1$), suggesting observational benefits; however, there was no obvious supporting data for observational learning in this study. Subsequently, Baker et al. (1986) studied observational learning in horses using a different task; the observer horse was allowed to see another horse find grain in one of two feed buckets (one black, the other white). No significant differences occurred between experimental and control groups; thus, observational learning was not demonstrated. Similar conclusions were made in the observational learning studies of Clarke et al. (1996) and Lindberg et al. (1999).

Undoubtedly some behavioral traits that horses acquire are learned more quickly because of the following along with experienced herd members. Moving toward and using a new water hole is an example. Yet as with other forms of learning, considerable research is needed before a definitive explanation about the acquisition of the numerous learned traits of horses can be given.

Imprinting

Imprinting is where a long-term association is acquired through learning during a sensitive period in an animal's life. First described in birds, imprinting-like phenomena are now recognized in a variety of vertebrate animals. In the known cases, these learned traits may establish a food preference,

a preference for a specific site, a preference for a type of mate, an infant's preference to associate with a particular species, or a preference of a mother for a particular infant. The last two types are especially evident in horses—both are forms of social imprinting (also called object imprinting, filial imprinting, and primary socialization). Marinier and Alexander (1995) have theorized food imprinting may occur in horses in the first two months postpartum; in their view, coprophagy of maternal feces may play a role in grazing selectivity.

The sensitive period for social imprinting of young animals may be soon after birth or hatching, but in altricial species it may be delayed until sufficient development occurs in the sensory and motor systems. Newborn foals are precocial, thus delay of their sensitive period does not occur. Their sensitive period for social imprinting is first evident during the second hour of age (Waring 1970b). Once social imprinting (primary socialization) is established, the individual is less inclined to form an association with additional objects; thus, the sensitive period appears to wane in the first day of a foal's life but may last for several days if the foal has been isolated from potential companions. Once the initial social imprinting has occurred, the individual is inclined to form secondary affiliations with like objects as its life proceeds. A foal typically forms its initial social attachment to its own mother and hence to its own species; however, Grzimek (1949a) reported that a foal isolated from its own species for the first 64 days exhibited a social preference for only its human companions when given free choice. It has not been determined if such a horse would maintain its foster-species preference into adult life nor what behaviors would be affected in maturity.

In horses, social imprinting is not unique to foals—a similar phenomenon occurs in their mothers soon after parturition. It is the “mothering-up” process, long known in animal husbandry. The sensitive period in mares begins at parturition and lasts until the mother can successfully identify and affiliate with the neonate—usually this is accomplished in the first hour or two postpartum. During the sensitive period, each mother rapidly learns to distinguish her foal—at least chemical cues are involved. Once the mare has developed an attachment for a foal during the sensitive period, it is difficult to get her to accept any other neonate.

Aside from the topic of social imprinting, additional sensitive periods for other forms of learning are conceivable in horses. As a foal develops, there may be stages in its development where specific learning is easily and typically accomplished—perhaps things important for survival or for becoming a successful adult. Systematic research into such possibilities is needed.

Memory

Memory is often studied at one of three levels—working memory, short-term memory, or long-term memory. During the immediate process of learning, an organism is likely using its working memory. Distractions or loss of attentiveness disrupt such memory. However, if attentiveness and the animal's capability are adequate, soon the trait is learned in short-term memory and can be demonstrated repeatedly over the course of a few hours. Subsequently long-term memory of the learned trait usually ensues. But long-term memory does not always get established. Physical or psychological trauma or certain other disruptions to an animal's system can eliminate short-term memory before it has become established more permanently. Thus long-term memory that would have developed from short-term memory does not develop. Nevertheless, when a horse can demonstrate a learned trait weeks or months after the last training session, clearly long-term memory is involved (examples are mentioned in the paragraphs above).

Grzimek (1949c) investigated memory in horses using variations of a delayed reaction experiment where food was hidden in one of three or four boxes as a horse watched. After a slight delay, the horse was allowed to make its choice. The procedure eventually adopted was to have either of two subjects stand four meters from an array of four adjacent choice boxes. Grain was overtly dumped into one box, the handler then stepped behind a screen, and after the scheduled delay the horse was given the command "come." One horse (a mare) achieved the correct choice only up to six seconds of delay; at 15 seconds, her performance was at the level of chance. The other horse, a gelding, achieved a delay of as much as 60 seconds before his performance approached that expected by chance. A yearling filly tested by Nobbe (1978) using a two-choice delayed-reaction procedure and a modified Wisconsin General Testing Apparatus achieved a delay of 24 seconds with accuracy above 80 percent. Unfortunately, the study had to be terminated before longer delays could be tested.

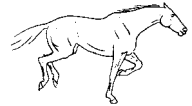
The studies reviewed above by Giebel (1958) and Dixon (1966) have shown horses trained to do multiple 2-choice discrimination tasks remember correct choices for several months without further training. However, the limits of memory in horses has not been investigated adequately. Without a capacity for memory, horse training would not succeed and horses would not be as valuable to humans. Variation undoubtedly occurs depending on the situation and the individuals involved. But the way some horses react with anxiety to situations that brought them fear or harm during a single event years earlier provides evidence that horses do have a remarkable capacity for long-term memory.

Part III



Maintenance Activities

8 Resting and Sleep



Horses rest periodically, where they cease all activity and become quiescent. Sleep occurs in some of the rest periods. The daily sleep cycle of horses is polyphasic, that is, with more than one period of sleep occurring per 24-hour period. Overall, horses exhibit a 24-hour pattern of rhythmicity in their behavior; yet ultradian rhythms may also occur—for example, based on 4.8 or 12 hours (Berger et al. 1999).

In foals, brief naps may first appear in the second hour after birth. Resting bouts occupy more than half of a foal's time until about 3 months of age; the frequency then begins to decrease (Tyler 1969). For most resting bouts, young foals become recumbent; yet, after 5 months of age, standing becomes the more common resting posture, at least during daylight hours (see Figure 4.6). Nevertheless, youngsters rest in sternal or lateral recumbency more than adults.

Adult horses frequently rest while in a standing position. The so-called stay apparatus of the limbs (involving various ligaments and tendons in the legs) in conjunction with the check apparatus of the forelimbs and reciprocal apparatus of the hindlimbs enable a horse to relax while standing without collapsing (Adams 1966). Winchester (1943) found that standing, not recumbency, is the posture of minimal energy demand on horses. Recumbency causes some cardiac, respiratory, and other internal stress due to compression of organs and pressure against the substrate. Nevertheless, recumbency occurs in most horses at least once each day provided environmental conditions are not too stressful or severe.

In stabled horses, Steinhart (1937) found 11.5 percent of each day was spent lying down in either lateral (4.0 percent) or sternal (7.5 percent) recumbency. The stabled horses observed by Ruckebusch (1972) were recumbent 8.2 percent of the average 24-hour cycle. During the nighttime

period alone, recumbency occurred an average of 19.9 percent of the time. During summer nights, Keiper and Keenan (1980) observed feral ponies spent 23.5 percent of the nocturnal period resting in the standing posture and 16.5 percent in a recumbent position. The field data gathered over a three year period by Duncan (1980) showed a trend for horses to spend less time in recumbency during colder months and more time resting in the standing posture. He also found adult females rested more in the standing posture and spent less time in recumbency than any other sex/age class. As the population under observation doubled over the three years, there was a general trend for all animals to spend less time in recumbency and to correspondingly increase time resting in the standing posture.

In the standing posture, a resting horse is supported usually by only three legs (Figure 8.1) with the slope of the neck lower than when attentive and alert. The muscles relax, the ears rotate laterally, and the eyelids and lips get droopy. As slow-wave sleep proceeds, the eyes tend to close and the neck often continues to relax; in the extreme, the crest of the neck may drop 20° or more below horizontal, with the dorsal surface of the head sometimes reaching vertical (as in Figure 8.1). The individual may remain sleeping in this posture for many minutes before arousing. Contrary to the opinion of some clients on rented horses, horses do not actually sleep while walking.

During a period of arousal from standing sleep or as a horse first becomes drowsy, it may recline to sternal recumbency (Figure 8.2a). While in sternal recumbency the individual may fall asleep and relax the head and neck.

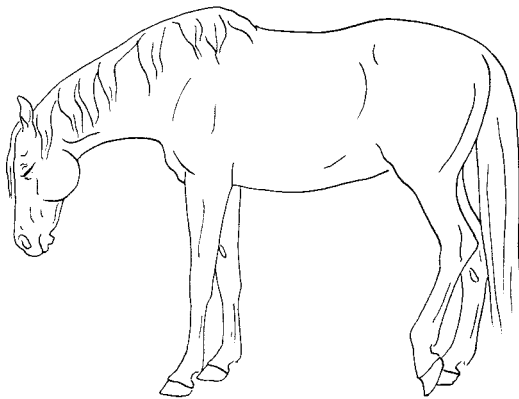


Figure 8.1: Resting with weight distributed among only three of the legs.

If sleep progresses while still in sternal recumbency, the relaxed neck often causes the mouth and lips to contact the substrate (Figures 8.2b,c). Sleep may proceed in that posture or the head may extend allowing the ventral surface of the lower jaw to rest on the substrate.

It is not unusual to see horses become drowsy and fail to initially assume lateral recumbency. They doze off repeatedly, for example, while standing or in sternal recumbency sunning themselves. After several brief bouts of slow-wave sleep, they may eventually assume lateral recumbency (Figure 8.2d).

In lateral recumbency, the side of the head and neck are placed on the substrate as the body shifts completely onto one side. The legs become somewhat extended, the eyes may then close, and as sleep proceeds the facial and skeletal musculature relaxes further.

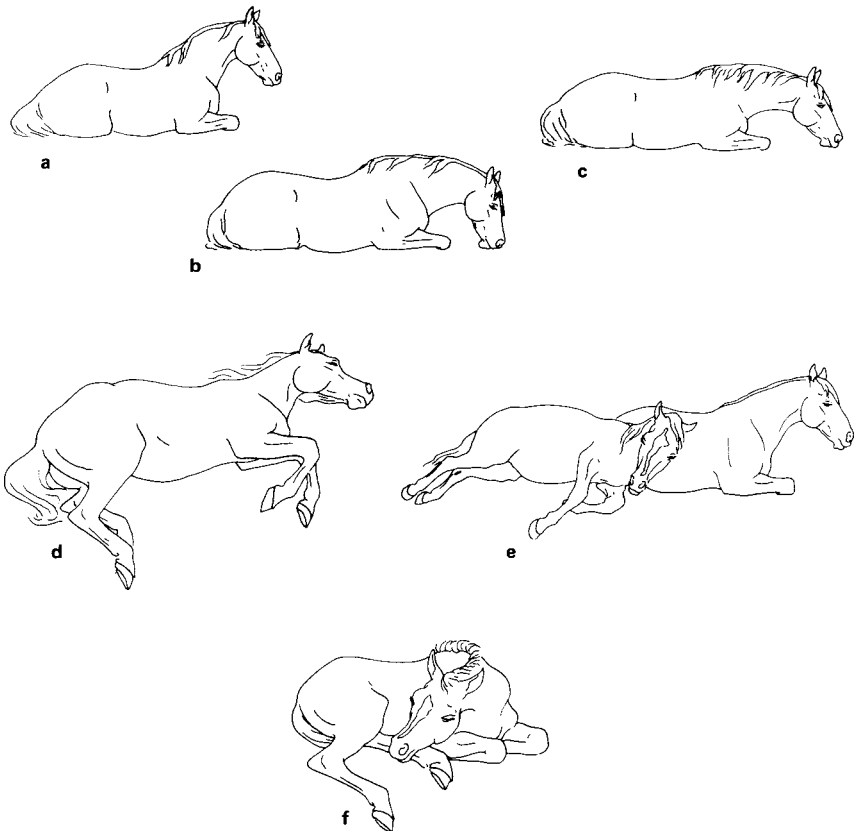


Figure 8.2: Resting attitudes assumed by recumbent horses.

Lateral recumbency can last for as long as 60 minutes, although Steinhart (1937) reported an average of 23 minutes for the stabled horses he observed.

Similar to other mammals, including humans, the horse exhibits different states of wakefulness and sleep, e.g., alert wakefulness, drowsiness, slow-wave sleep, and paradoxical sleep. Drowsiness is intermediate between alert wakefulness and slow-wave sleep. Slow-wave sleep is the initial and more frequent form of equine sleep and can occur in a standing or recumbent position; it occurs before each bout of paradoxical sleep. Paradoxical sleep is a very deep sleep occurring in lateral or occasionally sternal recumbency. Although an animal is difficult to arouse during this stage of sleep, its electroencephalographic pattern and muscular activity would suggest it is almost awake, hence the name paradoxical sleep.

Ruckebusch et al. (1970) and Ruckebusch (1972) studied sleep in horses using electrocorticographic (ECoG) recordings. They found alert wakefulness as well as paradoxical sleep exhibited desynchronized ECoG recordings showing low amplitude, low voltage, fast activity. Slow-wave sleep was characterized by relatively synchronized high amplitude, high voltage, slow activity. And drowsiness showed a sequential mixture of both low voltage, fast activity and high voltage, slow activity. Heart and respiratory rates decreased as subjects progressed into deeper sleep; yet, heart rate often elevated again within bouts of paradoxical sleep (Table 8.1). During paradoxical sleep, bursts of rapid eye movement (REM) and oftentimes movement of limbs, ears, and facial musculature occurred. Rapid heart rate (tachycardia) and increased respiration (polypnea) were common during REM bursts in the course of paradoxical sleep. Eye closure was complete in paradoxical sleep, but not necessarily in slow-wave sleep. During the sleep period, loss of muscular tone was initially gradual then commenced rapidly about mid cycle of slow-wave sleep and remained negligible during paradoxical sleep. A more detailed summary of the physiologic characteristics of equine sleep is given by Dallaire (1986).

Table 8.1: Cardiac and Respiratory Rate in Different States of Wakefulness and Sleep

	Alert Wakefulness	Drowsiness	Slow-wave Sleep	Paradoxical Sleep
Heart rate	43.5±5.1*	41.7±2.9	39.0±2.9*	41.8±1.7
Respiratory rate	19.6±4.8*	12.5±2.8*	9.8±1.7*	10.0±2.6

* $P \leq 0.05$
Data from Ruckebusch et al. 1970

Drowsy horses become alert to new sounds in their environment, whereas horses in deep sleep are not easily aroused. The threshold for arousal by audiostimulation increases by approximately a factor of 10 during slow-wave sleep compared to that during drowsiness (Ruckebusch 1972).

The daily pattern of sleep in horses varies from one environmental situation or season to another. Some horses sleep only at night; others utilize daylight periods. Individuals seem to have their own specific sleep-wakefulness pattern, varying less than 5 percent from day to day; whereas variation between individuals kept under the same conditions can be 10–25 percent (Ruckebusch 1972). Many observers (e.g., see Tyler 1969; Welsh 1975; Feist and McCullough 1976; Keiper and Keenan 1980) have noted recumbency and sleep in free-roaming horses occur during daylight as well as nocturnal hours. Kaseda (1983) found free-ranging Misaki horses in winter spent more total time resting per day (27.3 percent) as well as more time resting at night (22.8 percent) than in summer (19.7 percent and 8.7 percent, respectively).

Ruckebusch (1972), monitoring stallions in barn stalls, found sleep in his experimental subjects occurred only at night. The data he accumulated on three stallions by ECoG monitoring for periods of two to three consecutive 24-hour periods per week are shown in Table 8.2 and Figure 8.3. The wakeful state occupied on the average 88.8 percent of the 24-hour period and 71.4 percent of the nocturnal hours. Drowsiness, although of short duration relative to ruminants, occurred numerous times each day. Paradoxical sleep bouts averaged over five minutes and recurred several times each rest period. Tachycardia and increased breathing during paradoxical sleep occurred independent of limb movement, suggesting they were a direct result of dream-like episodes. Bouts of leg, ear, and eye movement as well as clonic contractions of the face plus vocalizations during paradoxical sleep suggest that horses experience vivid dreams.

Diet is one of the various factors that affect patterns of sleep and wakefulness in horses. Dallaire and Ruckebusch (1974a) determined that ponies housed under a controlled temperature and light regimen with free access to hay and water exhibited a total daily pattern of about four hours in sternal recumbency and one hour in lateral recumbency. When oats were substituted for hay, the total recumbency time was increased by about 20 percent. Sternal not lateral recumbency accounted for the increase. Total sleep time (slow-wave sleep plus paradoxical sleep) also increased; paradoxical sleep remained about 25 percent of the total sleep time. Similar results occurred after two or three days of fasting with only water available.

Table 8.2: Proportion of Time Spent in Sleep versus Wakefulness*

	10-hr Night Period	24-hr Period
Total duration and percentage		
Wakefulness		
Alert wakefulness	5 hr 14 min (52.4%)	19 hr 13 min (80.8%)
Drowsiness	1 hr 54 min (19.0%)	1 hr 55 min (8.0%)
Sleep		
Slow-wave sleep	2 hr 5 min (20.8%)	2 hr 5 min (8.7%)
Paradoxical sleep	47 min (78%)	47 min (3.3%)
Posture		
Standing	8 hr 1 min (80.1%)	22 hr 1 min (91.8%)
Recumbant	1 hr 59 min (19.9%)	1 hr 59 min (8.2%)
Ratio (as percentage)		
Drowsiness: Total wakefulness	26.63%	9.06%
Paradoxical sleep: Total sleep	27.32%	27.32%
Mean duration and no. of periods		
Drowsiness	3 min 56 sec (29)	3 min 29 sec (33)
Paradoxical sleep	5 min 13 sec (9)	5 min 13 sec (9)

*Average values for three stallions housed in stalls.

Data from Ruckebusch 1972

The level of stimulation or boredom may affect the sleep patterns of horses. Dallaire and Ruckebusch (1974b) found partial sensory deprivation increased total slow-wave sleep in ponies; some increase in paradoxical sleep occurred. Conversely, horses may exhibit more drowsiness and less deep sleep (slow-wave and paradoxical sleep) when housed outdoors (Dallaire 1986). In a nighttime study of mares two weeks before and after giving birth (Houpt et al. 1986), stabled mares exhibited more sternal recumbency (12–13 percent) than mares on pasture (4–6 percent).

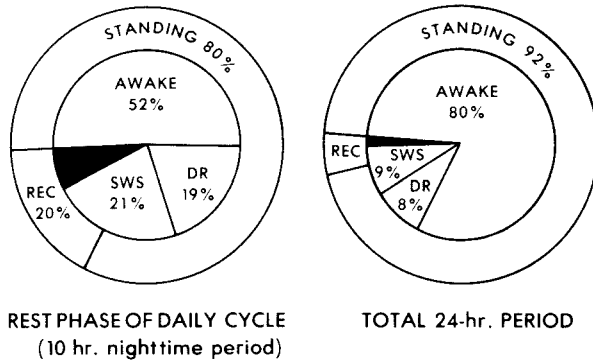
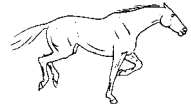


Figure 8.3: Average sleep and wakefulness pattern of three stallions monitored electroencephalographically while in stalls. Outer circle shows postures, and the inner circle represents the relative duration of sleep and wakeful states. Paradoxical sleep is shown in black; DR = drowsiness; SWS = slow-wave sleep; REC = recumbent. (Adapted from Ruckebusch 1972)

However, within each treatment group, the amount of sternal recumbency pre- versus post-partum did not shift significantly. The peri-parturient mares rarely exhibited lateral recumbency (0–1.4 percent).

Compared to sheep and cattle in the same pasture, horses have a different time budget and rhythmicity. Arnold (1984b) found horses spend very little time recumbent and grazed far more at night than sheep or cattle.

9 Ingestive Behavior



Ingestive behavior includes feeding as well as drinking. Drinking is relatively infrequent. However, feeding and resting occupy most of a horse's day. As one increases, the other typically decreases proportionally. Feeding predominates when horses are on pasture or open range and must actively seek sufficient forage to satisfy their needs.

Horses are adaptable to a variety of foods and ingestion schedules. They can tolerate rather desolate conditions with a scarcity of food and water; yet, horses show a preference for grasses and grass-like plant materials as well as for a nearby water source. Unlike ruminants, their cecal digestion, high intake, and rapid food passage enable horses to adequately maintain themselves on a high fiber, low protein diet (Janis 1976). When preferred foods, such as grasses and legumes, are no longer available, their diet may include roots, herbs, shrubs, woody plants, or aquatic plants; oftentimes, a variety of foods are consumed in one day. Seasonal variation in ingestive behavior occurs in most locations. Thus during an annual cycle male and female horses vary their feeding times, but only slightly. For example, the 24-hour feeding time of weaned, free-ranging Camargue horses varied by less than 10 percent in relation to age, gender, and reproductive state (Duncan 1992b).

In horses, the lips and tongue are especially agile and accomplish manipulation of food and placing it in the mouth. Attached food items are snipped free by the upper and lower incisor teeth and a quick yank of the head. Once food is within the mouth, mastication is accomplished by the grinding action of upper and lower cheek teeth (the molariform premolars plus molars).

Foals commence nursing within an hour or two of birth. Nursing declines over the next few months as time spent grazing increases. In the review that

follows, nursing will be considered separately from other feeding and drinking behaviors.

Feeding

While grazing or browsing, horses manipulate plant materials with their dexterous upper lip. The preferred plant items are isolated from adjacent materials using the upper lip, then the bundle is passed between the upper and lower incisor teeth where biting, assisted by a jerk of the head posteriorly, snips off the leaves or other parts, and with the aid of the tongue the materials are ingested into the mouth for chewing (see Figure 6.1). Other bites may be taken before a bout of chewing commences. Hay, grains, and concentrated feeds are ingested with the combined action of tongue and lips followed by chewing.

Grinding of the food with the well-suited cheek teeth occurs at a rate of 1 to 1.7 times per second (Okuda et al. 1980). The macerated material is then swallowed as one or more boluses of food passing along the esophagus to the stomach of 7–14 liter capacity. Commonly, a horse shifts its neck from side to side as it grazes slowly forward, stepping to make additional plants accessible. Selective feeding is typical, yet individuals vary in their selectivity (Marinier and Alexander 1991; 1992).

The rate of feeding varies with the situation. On a Himalayan alpine meadow, Negi et al. (1993) found horses averaged 51 bites/min and 99 milligram dry weight per bite; total intake was 3.25 kg dry matter per day (40 percent was forbes). Duren et al. (1989) observed the ingestive behavior of exercised versus unexercised yearling horses grazing orchardgrass (*Dactylis glomerata*). The unexercised yearlings ate at the rate of 14.8 bites/min with intake at 861 mg/bite, whereas the exercised individuals (during the first 20 minutes following exercise) ate at the rate of 12.6 bites/min with intake at 865 mg/bite. Thus, taking fewer but larger bites characterized the yearlings who had experienced exercise prior to feeding.

In most cases, the neck must be lowered to place the mouth close to the food material. The body axis is often kept parallel to the direction of wind, and a vigilance is maintained using the eyes and ears. While chewing, the neck and head are momentarily raised and observations of the surroundings are made before the grazing pattern then continues.

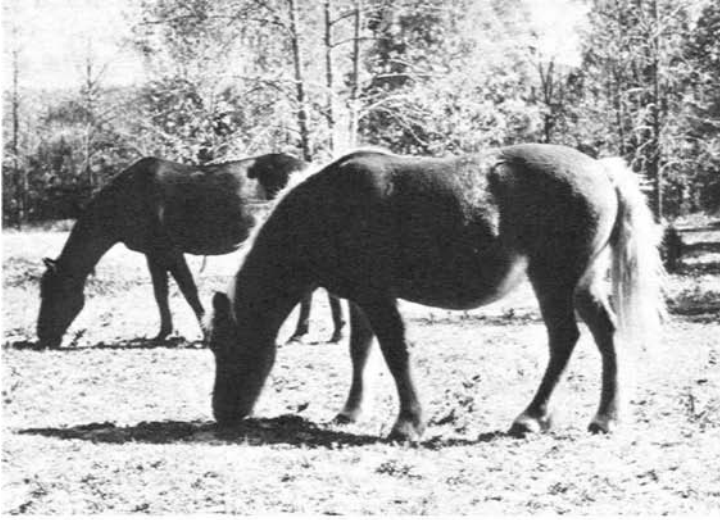
It is not unusual for an entire herd to graze at the same time and in the same direction, maintaining an individual distance of at least one meter

between each member of the group (Figure 9.1). Even in stables, social factors can influence feeding. For example, Sweeting et al. (1985) found ponies in individual stalls spent considerable time feeding when they could maintain visual contact with their neighbors; however, when solid partitions prevented visual contact, the ponies reduced their feeding time (especially in the afternoon) and spent more time standing alert.

Sometimes horses must dig for food by pawing with a foreleg. In winter, pawing is especially utilized in deep snow where numerous strokes may be used to clear a crater and expose plants. In a snow depth of 40–50 cm, Salter and Hudson (1979) found horses pawed an average of 9.7 times per bout (9.1 bouts per 5 minutes) compared to 5.4 strokes per bout (1.4 bouts per 5 minutes) when the snow depth was 10 cm. In shallow snow, horses push away the snow with their muzzle without the need for pawing. In arid habitats where food supplies have dwindled, horses dig up roots using pawing movements.

When feeding on submerged aquatic vegetation, a horse may need to immerse its muzzle well below the water surface. Some stabled horses learn to moisten dry forage by hay dunking—the dunking of roughage into their water supply before chewing (cf. McDonnell et al. 1999). One mare I observed in detail lifted hay routinely to a shelf near an automatic waterer and would proceed to dip mouthfuls of hay at the average rate of 5.1 per minute between bouts of chewing. If the waterer was turned off, or if the roughage was fresh cut or previously moistened, the mare would not do the dunking routine before swallowing (Waring 1974).

The time of day as well as the total time spent feeding are dependent on the quality and quantity of food available to horses, plus such factors as exercise, lactation, weather, and insect pests (e.g., see Martin-Rosset et al. 1978). Environmental disruptions, such as storms or intruders, can temporarily cause horses to discontinue grazing. Social factors also influence feeding patterns; for example, as one horse begins to graze other group members are more inclined to graze (a form of social facilitation). Under free-ranging conditions, feeding tends to occur as meals separated by intervals of varied length (Mayes and Duncan 1986). Stabled horses fed limited amounts of concentrates, grain, and hay generally consume their ration in one feeding bout and, thus, are unable to exhibit ingestive behavior for the rest of the day. With food made constantly available, Ralston et al. (1979) found ponies consumed 80 percent of their daily intake in an average of 10 separate meals. Each meal lasted 44 ± 10 minutes and averaged 0.5 kg of a pelleted ration; on this diet, 38 percent of the 24-hour day was spent feeding.



a.



b.

Figure 9.1: Typical feeding activity of horses showing (a) grazing and (b) foraging along surface for such items as acorns.

The average interval between meals was 84 minutes. Half of the intake was consumed between 0800 and 1700 hours. Houpt et al. (2000) noticed a significant decrease in time spent eating when pregnant mares were restricted in their water intake.

Horses on pasture tend to graze in cycles with three or more prolonged feeding periods per day. Breaks of up to several minutes may occur within a period of grazing, but long breaks separate one feeding period from the next. Francis-Smith et al. (1982), using a special electronic device attached the horse's halter, recorded a continuous bout of grazing lasting 178 minutes in a 760 kg male horse. When the automatic-recording device was used to monitor another horse's grazing behavior for seven 24-hour intervals spaced over several months, 5–7 major grazing periods characterized each day's feeding pattern with an average total grazing time of 15 hr 41 min per 24-hour day (range = 14 hr 34 min to 16 hr 50 min; 60.7–70.1 percent of 24-hour day). Observing yearling horses on pasture, Kusunose et al. (1986) found the mean duration of grazing bouts increased as group size increased from 1 to 4.

In general, undisturbed, free-ranging equids feed 59–69 percent (14–16.5 hr) per day (Duncan 1992b). Feeding is scattered throughout the 24-hour period so that the gut remains relatively filled, but as environmental conditions dictate certain hours are often emphasized more than others. Salter (1978) found feral adult horses of western Alberta fed about 75 percent of the daylight hours in winter and spring, whereas foals spent 41 percent of their time foraging. Similarly in England during winter, ponies ranging the New Forest spent most of their daylight hours grazing and browsing; but after May, resting time increased as grazing time decreased. Then as flies became abundant in June, the ponies remained in the shade with few feeding excursions between 0900 and 1400 hours (Tyler 1969). Both Tyler (1969) and Salter (1978) noted that peak grazing activity in daylight occurred about dawn and again in the late afternoon. One or two prolonged resting periods were typical between the peak feeding times.

In feral horses of Nevada, Berger (1986) found total time spent feeding was greatest in winter and least in summer. On average, stallions grazed 70.5 percent of the daylight period when their home-range quality was poor, but when stallions had access to high-quality food their grazing time was 57.9 percent. Similarly for mares on poor forage, the total daylight feeding time was 68.3 percent for barren mares and 78.1 percent for lactating mares; on high-quality forage, barren mares fed 58.4 percent and lactating mares fed 65.8 percent of the daylight hours.

For free-ranging Misaki horses of Toi Cape in Japan, Kaseda (1983) found grazing centered on quality grasslands during the growing season; however, in winter, those sources waned and the horses frequented forests and weedy grasslands. Grazing in winter occupied 71 percent of the 24-hour period, whereas in summer grazing occupied 76.1 percent of each day. Nighttime grazing was common in summer but was relatively low in winter.

Grazing at night can be a common activity for horses. For example, on Assateague Island along the Maryland-Virginia coast, feral ponies during summer nights were found to graze 54.6 percent of the nocturnal period (Keiper and Keenan 1980). Although grazing occurred periodically through the night, there was a tendency for greatest feeding activity early in the evening and again at dawn. On a barrier island of North Carolina, Rubenstein (1981) found extensive nocturnal foraging occurred, declining only slightly from the daylight rate; the feral horses he observed fed 75 percent of the 24-hour day.

In Poland, Kownacki et al. (1978) seasonally sampled day- and night-time behavior of horses on a forested reserve. They found adult horses foraged nearly 70 percent of each 24-hour day, with little apparent change in the total grazing time between early summer, fall, and winter. During the winter, supplementary hay was utilized.

In the Camargue region of southern France, Duncan (1980) found a slight tendency for mares to spend more of their time (58.5–63.1 percent) foraging in all seasons than mature stallions (50.8–59.7 percent). Winter forage was scarce. In the growing season, horses fed extensively on emergent marsh vegetation.

Foals do little grazing during their first few weeks and unless utilizing a slope or hummock must spread their forelegs to allow the mouth to reach plants close to the ground. Some foals reach the plants by flexing the forelegs at the knees. As the foal develops, grazing activity increases. Tyler (1969) found a tendency for foals not only to graze more with age but also to graze significantly more ($P < 0.001$) during the late afternoon (Figure 9.2). Crowell-Davis et al. (1985b) found similar trends; in their study, foals also showed a second period of feeding during early morning. Almost all grazing by foals was done while their mothers grazed. On several occasions foals were seen to eat humus. In the Red Desert of Wyoming, Boyd (1980) noticed a two-day-old orphan foal in its effort to survive cropped tips of grasses and brush with little selectivity.

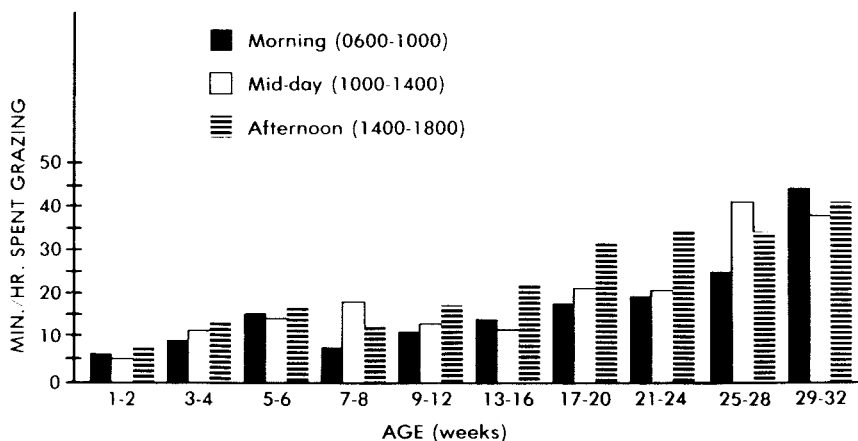


Figure 9.2: Grazing activity of foals during daylight. (Data from Tyler 1969)

Food Selection and Preferences

Horses do not evenly graze all plants in their habitat. In each environmental setting they typically show preferences for certain plant species and may avoid others. Selectivity is not unique to gender or age group (Lenarz 1985). Relatively short, new growth is often favored. In pastures, a grazing pattern usually becomes evident where horses feed heavily in certain areas and utilize other portions of their available space for eliminative areas (Taylor 1954; Ödberg and Francis-Smith 1976). The areas grazed become cropped close to the ground, and taller rough vegetation develops in the defecation areas where feeding rarely occurs. Ödberg and Francis-Smith (1977) concluded horses tend to defecate in the areas used previously for elimination and, thus, these areas become seldom-grazed zones. The physical presence of feces may deter grazing more than palatability of the vegetation. In tests made by Archer (1978a), horses did not graze where feces were placed but did defecate on those sites; moreover, the horses grazed test plots treated with urine only.

Horses accept a variety of foods and some individuals avoid foods readily accepted by other horses, thus it is not easy to pinpoint absolute preferences for the species and research results vary from one situation to another. Archer (1971; 1973) showed horses (when allowed to graze pure plots of 29 species of grasses, legumes, and herbs plus plots sown with

seed mixtures of two kinds) foraged in all the test plots; nevertheless, the horses spent more time grazing a white clover-rich dryland mixture than the other choices during the many months of data collection. Desirable foods included perennial ryegrasses, timothy, cocksfoot, crested dogstail, wild white clover, dandelion, ribgrass, chicory, yarrow, burnet, and sainfoin. Based on time spent grazing, species ranked low preference included red clover, meadow foxtail, and brown-top. In a subsequent study, Archer (1978b) assessed palatability of 12 grasses by measuring plant height before and after grazing by horses. Using this methodology, there were significant grazing-preference differences between the grasses, with the most palatable being creeping red fescue (*Festuca rubra*) and tall fescue (*Festuca arundinacea*) and, of the remaining grasses tested, the least grazed were perennial ryegrass (*Lolium perenne*) and meadow foxtail (*Alopecurus pratensis*).

When provided a choice of oats, maize, barley, rye, and wheat, the pony mares tested by Hawkes et al. (1985) preferred oats, then cracked maize, and next barley. In another two-choice experiment, four of six pony geldings chose oats with sucrose (2 percent and 10 percent) compared to plain oats. And in a third two-choice experiment, variants were compared to a basal mixed feed diet (consisting of 54 percent maize, 20 percent whole oats, 10 percent wheat bran, 8 percent soybean meal, 7 percent molasses, and 1 percent limestone). Beginning the second day, the pony mares being tested showed a strong preference for a feed containing 20 percent dried distillers' grain compared to the basal mixture. The basal mixture, however, was preferred when tested against diets containing 20 percent blood meal, 20 percent beet pulp, and 20 percent meat and bone meal. The mares did not differentiate against diets containing 20 percent alfalfa meal when compared to the basal mixture nor did they differentiate against meat and bone meal when fed at 5 percent and 10 percent.

When given a choice, horses sometimes show preference for certain forms of a foodstuff. For example, Haenlein et al. (1966) found horses consumed 17 percent more alfalfa as wafers and 24 percent more as pellets than as loose alfalfa hay. Horses tend to refuse concentrated citrus pulp, but will consume it in pelleted diets up to a level of 15 percent (Ott et al. 1979). Taste, texture, and odor clearly influence horse feeding; yet, feed intake as well as meal frequency are also influenced by gastrointestinal, metabolic, and environmental cues (Ralston 1984). There appears to be no correlation between the energy content of a given feed and a horse's preference for that feed; nevertheless, based on hunger and external stimuli, the horse will

regulate its body weight if given the opportunity to adapt to a single feed over the period of a few days (Ralston 1986).

The response of horses to sweet, salty, sour, and bitter solutions was studied by Randall et al. (1978) using two-choice preference testing on five weanling foals. Sucrose was preferred to tap water in concentrations ranging from 1.25 to 10 g/100 ml; concentrations above and below this range resulted in indifference. Although indifferent to weak solutions, the horses began to reject salt (NaCl) solutions above 0.63 g/100 ml. Sour solutions (acetic acid) were rejected in concentrations of 0.16 ml/100 ml and above. And bitter solutions (quinine) were rejected in concentrations above 10 mg/100 ml.

The diets of horses vary greatly between one habitat or management situation and another. Horses also vary in their individual grazing selectivity (Marinier 1980). In general, horses are opportunistic feeders, selecting the most palatable and accessible items available to them. Thus, in confinement, they will accept pelleted purified diets (Stowe 1969). In marsh habitats, they will eat emergent as well as submerged aquatic plants (Ebhardt 1957; Göbel and Zeeb 1963; Tyler 1969; Duncan 1980). In woodlands, they browse on a variety of plants and will consume bark, buds, leaves, and fruits. In the fall, some ponies Tyler (1969) observed spent much of their day grubbing under oaks for fallen acorns. In other circumstances, horses may seek roots. Yet, it remains that horses, just as is assumed of their recent ancestors, are primarily grazers, choosing grasses and grass-like forages whenever feasible for the bulk of their diet.

Diets can change from season to season because of plant accessibility and as alterations occur in the plant materials. For example, Jordan and Marten (1975) found horses readily ate reed canarygrass (*Phalaris arundinacea*) early in the growing season but by July and August palatability for this plant diminished, seemingly because of an increase in its alkaloid content. Seasonal changes in use of vegetation occurs in ponies of the New Forest (Putman et al. 1987). Studies of Camargue horses roaming the Rhône Delta have shown the horses range widely each month using much of the habitat available to them; yet, they are highly selective utilizing each variation in food and habitat differently from month to month but similarly between years (Duncan 1992b).

The analysis of diets of free-roaming horses is typically done by microscopic techniques to determine the botanical composition of plant remains in samples of fecal material. These data are used to estimate the percentage of dry weight of the various plant species in the diets of the animals. For example, in a study of feral horses of western Colorado, Hubbard and

Hansen (1976) found diets in mountain shrub areas emphasized sedges (46 percent) which were relatively abundant, but the diet also included some grasses and a shrub (Utah serviceberry). In lower pinion-juniper areas, several kinds of grasses dominated the diet (Table 9.1). A single woody plant (common winterfat) was used relatively often for food, yet averaged 7 percent or less in the diet in both plant zones. Feist and McCullough (1976) noticed horses dug for the roots of this plant.

In another study (Hansen 1976), feral horses living on the desert grassland areas of southern New Mexico showed diets emphasizing Russian thistle, grasses, and mesquite. Seasonal use varied greatly; mesquite pods and leaves made up 53 percent of the September diet of these horses, yet only 2 percent in March. In sagebrush-saltbrush-rabbitbrush areas of the Red Desert of Wyoming, grasses were mainly used for food (Olsen and Hansen 1977). Farther north in the foothills of Alberta, free-roaming horses fed on numerous plants but greatly emphasized grasses and sedges (Salter and Hudson 1979). At coastal sites, cord and beach grasses seemed to be the major diet (e.g., see Zervanos and Keiper 1980).

Aside from what can be considered normal diets and usual feeding behavior, some horses spend time ingesting fecal material (coprophagy), eating mud, or chewing wood. Coprophagy can be common in foals up to a month of age (Tyler 1969; Blakeslee 1974), but it wanes thereafter. Usually only one or two pellets are eaten subsequent to a bout of pawing the material. The feces ingested are most commonly those of the mother. Such behavior may aid foals in acquiring beneficial intestinal microorganisms, yet parasites too get ingested. Coprophagy is rare in adult horses, although stallions are especially eager to investigate feces and add to existing piles. Feist and McCullough (1976) suggested that occurrences of coprophagy by older free-roaming horses may be due to food scarcities. As examples, they reported observations of mares and their offspring eating old pellets from stallion fecal piles during August and winter.

Soil ingestion, although apparently not frequent, has been observed in horses under varying circumstances. Feist (1971) recalled seeing non-feral horses ingest soil from newly plowed fields in Canada and observed a lone feral stallion on the Pryer Mountain Wild Horse Range in May eat dark gray mud from a nearly dried up puddle. Salter and Hudson (1979) found free-roaming horses in Alberta ingested throughout the year quantities of soil at salt licks established for cattle as well as at natural mineral licks. Supplementation of dietary sodium has been suggested as the primary benefit of soil ingestion (Salter and Pluth 1980).

Table 9.1 Variations in Diets of Free-Roaming Horses in Different Habitats of North America

Plant Species	Habitat Where Utilized					
	Barrier Island (Md/Va)	Desert Grassland (N. Mex.)	Desert Shrub (Wyo.)	Pinon-Juniper (Colo.)	Mountain Shrub (Colo.)	Boreal Forest (Alberta)
Grasses and Grass-likes:						
Sedge (<i>Carex</i> spp.)			*	*	**	**
American Three-Square Sedge (<i>Scirpus americanus</i>)	*					*
Cotton Grass (<i>Eriophorum viridi-carnatum</i>)						*
Wire Rush (<i>Juncus balticus</i>)			**	**	*	*
Needlegrass (<i>Stipa</i> spp.)			**	**	**	
Wheatgrass (<i>Agropyron</i> spp.)		*	**	*	**	*
Junegrass (<i>Koeleria cristata</i>)		**	*	**	*	
Brome (<i>Bromus</i> spp.)						*
Tufted Hairgrass (<i>Deschampsia caespitosa</i>)						**
Hairy Wildrye (<i>Elymus innovatus</i>)						*
False Melic (<i>Schizachne purpurascens</i>)						*
Indian Ricegrass (<i>Oryzopsis hymenoides</i>)			**	*	*	*
Bluegrass (<i>Poa</i> spp.)			*	**	*	**
Fescue (<i>Festuca</i> spp.)		**				
Dropseed Grass (<i>Sporobolus</i> spp.)		*				
Spangletop (<i>Leptochloa dubia</i>)		*				
Gramma (<i>Bouteloua</i> spp.)		*				
Muhly (<i>Muhlenbergia</i> spp.)		*				
Bristlegrass (<i>Setaria macrostachya</i>)		*				
Hairgrass (<i>Agrostis scabra</i>)						*
Timber Oatgrass (<i>Danthonia intermedia</i>)						*
Salt-marsh Cordgrass (<i>Spartina alterniflora</i>)	**					

Continued on next page

Table 9.1 Variations in Diets of Free-Roaming Horses in Different Habitats of North America

Plant Species	Habitat Where Utilized				
	Barrier Island (Md/Va)	Desert Grassland (N. Mex.)	Desert Shrub (Wyo.)	Piñon-Juniper (Colo.)	Mountain Shrub (Colo.)
Boreal Forest (Alberta)					
Grasses and Grass-like:					
Salt-meadow Cordgrass (<i>Spartina patens</i>)	**				
American Beech Grass (<i>Ammophila brevilingulata</i>)	**				
Forbs, Browse, and Others:					
Rabbitbrush (<i>Chrysothamnus</i> spp.)		*			
Utah Serviceberry (<i>Amelanchier utahensis</i>)				*	*
Common Winterfat (<i>Eurotia lanata</i>)			*	*	*
Russian Thistle (<i>Salsola kali</i>)		**			
Mesquite (<i>Prosopis juliflora</i>)		**			
Saltbush (<i>Atriplex</i> spp.)		**			
Snowberry (<i>Symphoricarpos</i> spp.)			*		
Globemallow (<i>Sphaeralcea</i> spp.)			*		
Lodgepole Pine (<i>Pinus contorta</i>)			*		
Horsetail (<i>Equisetum</i> spp.)					*
Moss					*

* = Seasonal or annual diet 1 to 9%. ** = Seasonal or annual diet 10% or more.

Data from Hansen 1976; Hubbard and Hansen 1976; Olsen and Hansen 1977; Salter and Hudson 1979; Ford and Keiper 1979; Zervanos and Keiper 1980

Wood chewing, especially fence or stall chewing, can be observed in some confined horses. Softwoods as well as hardwoods are vulnerable. Destruction, of course, becomes more evident and widespread with the softer wood types. Horizontal boards as well as uprights at corners are the usual targets for chewing, wherever the animal stands for considerable time. Although some ingestion may occur, much of the chewed material falls to the ground.

Restlessness as well as dietary deficiency may justifiably be implicated in most cases of abnormal ingestive behavior. Willard et al. (1973) found ponies fed an all-concentrate diet spent more time chewing wood, eating feces, and licking salt than did ponies on a hay diet. Haenlein et al. (1966) found ponies maintained on pelleted food became nervous and exhibited wood chewing, although food was still available. Wafered food did not cause similar problems. In other studies (Willard et al. 1977), young horses kept on pelleted diets not only have shown wood chewing but also chewing on the manes and tails of other horses. To pursue the problem further, Willard and co-workers altered the diets and cecal pH of horses, while water and trace mineral salt were available free choice. Compared to horses on a non-pelleted concentrated diet, horses on a mixed grass-legume hay diet spent significantly more time eating ($P<0.05$) and significantly less time ($P<0.1$) in wood chewing, coprophagy, and food searching activity. Furthermore, horses on the concentrated diet with experimentally increased cecum pH (via sodium bicarbonate infusions) spent significantly more time standing ($P<0.05$) and less time in coprophagy ($P<0.1$) than did horses fed concentrate alone. Thus, the type of diet and factors such as increased cecal acidity appear to influence abnormal feeding behavior.

Drinking

Although ingested less often than food, water is an important resource for horses. A horse ingests water by immersing its almost-closed lips below the water surface and through a sucking action pulls the water into its mouth (Figure 9.3). A drinking bout consists of series of swallows. The horse then pauses to look around and, subsequently, may proceed to drink some more. Thus during one visit to the water source 4 liters or more may be consumed. Schiebe et al. (1998) found total daily intake varied among individuals and averaged between 2.4 and 8.4 liters. Sufit et al. (1985) noted pony geldings deprived of water for 19 hours initially drank an average of 10.2 kg/30 min when water was made available. In another study of four stabled pony

geldings from late March to early May, Sweeting and Houpt (1987) found an average of 15 swallows were made per drinking bout, with a mean of 70 g consumed per swallow. On average, the interswallow interval was 2.1 sec. The ponies repeated drinking an average of 3 times per hour, ingesting 1.6 kg per hour under *ad libitum* conditions.

Many sources of water are used for drinking, provided sufficient depth is available to allow for the immersion of the lips. Small pools resulting from precipitation or nearby springs suffice for many free-roaming horses. Sometimes horses create their own drinking pool by pawing a crater in sandy soil (Welsh 1973). Snow ingestion and succulent foods may help alleviate the demand for water.

The frequency of drinking varies with such factors as accessibility and physiological need. Usually regulation of water intake is under the control of plasma volume and osmolarity (Sufit et al. 1985; Ralston 1986). Following strenuous exercise horses drink more (Caanitz et al. 1991).



Figure 9.3: Drinking response of horses showing immersion of lips below water surface. (Photo courtesy of R.R. Keiper)

Drinking can be day or night with little fixed schedule. However, Ganskopp and Vavra (1986) noted feral bands tend to visit water sources especially early and late in each daylight period, vacating the site promptly thereafter. When water is readily within reach, horses drink small amounts several times in one day. Krysl et al. (1983) observed 5–7 drinking sessions each day in summer and 2–3 in winter. As accessibility of water diminishes, movement to water sources becomes less frequent. Free-roaming horses which may be several kilometers from their nearest water hole generally return and drink once each day (Feist 1971) or as little as every other day (Pellegrini 1971). In extreme heat, herds may remain near water and drink more often. Przewalski horses can apparently drink as seldom as every two or three days (Bannikov 1961).

Water temperature can affect water consumption. In cold weather, Kristula and McDonnell (1994) demonstrated horses consume more water when provided a source of warm water than when water is at ambient, near-freezing temperature. Based on two trials utilizing 14 ponies (ranging in age from 2 to 21), the ponies consumed in mid-winter an average of 40 percent more water when warm instead of cold water was available to drink. No qualitative differences in drinking behavior were detected in either trial.

When one horse moves toward water, the activity is contagious and others tend to join in the single file procession and the subsequent activity of drinking. When space is limited at the water source, the more dominant animals drink first. As each horse finishes drinking, it tends to wait for the remainder of the social group and all move away together. Feist and McCullough (1976) found a group begins to leave after drinking 2 to 10 minutes, rarely staying longer than 30 minutes. They noticed other bands of horses waited at a distance until the group at the water hole vacated the site. Pellegrini (1971) found the bands he studied sometimes spent the night near water holes after leisurely drinking. On Assateague Island during summer, feral ponies tend to move to water just before or soon after sunset; the highest incidence of nighttime drinking occurs during the first hour of darkness, although drinking behavior is also occasionally seen at other hours (Keiper and Keenan 1980).

Prior to weaning, drinking by foals is rare. On 19 occasions monitored by Crowell-Davis et al. (1985b), drinking by foals (less than 22 weeks of age) lasted 0.06 to 0.99 min (mean = 0.34 min). Drinking bouts of their mothers lasted 0.04 to 1.14 min (mean = 0.39 min); frequency but not duration of drinking increased in the mares as the temperature increased. Drinking was most common during afternoon hours.

Nursing

The sucking reflex of newborn foals can be induced soon after birth. Tactile stimulation along the mouth or muzzle induces the tongue to protrude slightly from the lips, the head and neck extend as well as elevate, and sucking motions of the mouth begin. During the first hour following birth, the drive to suckle appears to increase progressively and the response becomes easily induced by any contact with the lips or dorsal surface of the muzzle. Foals I have kept in sternal recumbency for their first hour to permit human fondling and socialization have shown spontaneous sucking in mid air at approximately 50 minutes of age even without tactile stimulation of their muzzle.

Besides displaying the sucking reflex, neonatal foals must achieve standing and exhibit teat searching behavior before nursing can be established. Also necessary for successful nursing is the cooperation of the mare. Some mares assist the searching behavior of their foals by presenting the flank region and nuzzling the foal into position. But oftentimes mares show no assistance, and their unsteady foals may spend many minutes searching between the mare's forelegs, probing her belly and sides, or even probing surrounding inanimate objects. Foals seem to be inclined to search under surfaces at about head height while trying to maintain tactile stimulation against the top of their muzzle. Tactile stimulation, rather than visual or chemical cues, appears to be the primary basis for such searching maneuvers with the head and mouth; nevertheless, foals are probably visually attracted to large objects and finally attach to a teat because of both tactile and chemical stimulation.

As foals begin to probe near the often sensitive udders, some mares resist by moving away, or they squeal and bump the foal by lifting the stifle region of the hindleg against the foal's neck or shoulder, causing the foal to withdraw. Once the nursing routine commences, the mare's discomfort eventually wanes.

With repeated searching and head extension near the mare's flank, a foal eventually locates one or both teats and commences to briefly suckle. Of the 245 Thoroughbred foals Rosedale (1967a) studied, nursing first occurred an average of 111 minutes after birth; yet the data ranged from 35 to 420 minutes. At subsequent nursings, the movements of a foal become increasingly more coordinated and directed toward the mare's flank, udders, and teats. Nursing bouts in stabled horses tend to recur at intervals of 10 to 90 minutes. The duration of a nursing bout tends to be slightly higher in the first few weeks then remains somewhat constant for months (see Figure 4.4);

between the weeks of 3 to 33, Kusunose and Sawazaki (1984a) found the mean duration of nursing was close to 70 seconds.

The usual nursing posture is where the foal places its head beneath the mare's flank while standing with its hindquarters near the mare's shoulder (Figure 9.4). Both teats can be reached without changing position. The mare often facilitates access by stepping forward yet leaving the hindleg on the foal's side in place exposing her flank. Commonly the mare turns her head and smells or licks the foal's hindquarters. Occasionally the foal's body is angled more perpendicularly to the mare's body; more rarely, some foals succeed in nursing from behind the mare by reaching between her hindlegs. If two foals nurse a mare at the same time, one foal typically assumes the common position along her side while the other reaches the remaining teat by using the between-the-hindlegs approach. An additional nursing posture, which rarely occurs, is for a standing foal to suckle while the mare is in lateral recumbency.

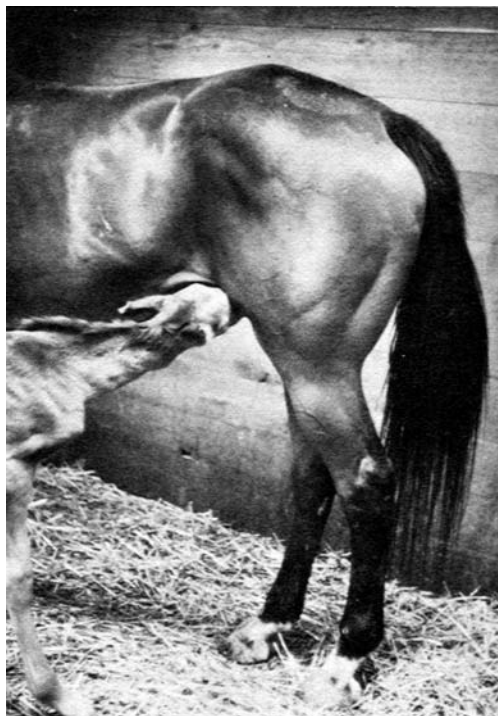


Figure 9.4: Typical nursing posture of foals.

A mare usually only allows her most recent foal to nurse. Weaning of the previous foal occurs weeks before or at the time the new foal is born. Occasionally, however, an older sibling succeeds in regular nursing subsequent to the arrival of the newborn. For example, Tyler (1969) observed a yearling nurse periodically for almost a week after the birth of its sibling, and in another case an 8-year-old filly nursed for several months subsequent to the birth of her sibling. In some instances where a mare fails to have a foal the following year, the nursing relationship is maintained with the yearling or an older juvenile. In most of these cases, weaning occurs before the next year; however, Tyler (1969) found a few immatures (two fillies and one colt) still nursed as 3-year-olds.

It is rare that a mare will allow any foal except her own to nurse. We had an instance, however, at the Southern Illinois University Horse Center where a dominant mare solicited nursing by positioning her flank to a receptive 2-day-old foal of a subordinate mare after the dominant's own newborn became unable to nurse because of a mouth injury the previous day. Both of the mares accompanied by their foals had just been turned out together into an outdoor paddock from their separate foaling stalls. The subordinate mare was noticeably distressed but did not intervene while her own foal nursed the dominant mare.

Although foals sometimes approach other mares with nursing foals, most females threaten and drive the strange foals away. Sometimes a strange foal succeeds in sucking momentarily. For example, one mare Tyler (1969) observed had her own foal at her side when a strange foal approached from behind and nursed for over a minute before the mare turned her head to her own resting foal then quickly shifted her head to the other side and bit and chased the intruder. In cases where a mare's own foal dies or is removed, her next youngest offspring often fills the social void and may nurse on a regular basis. To establish a foster mother-foal relationship, horsemen have found some success by draping the skin of the mare's dead foal over the strange foal.

Young foals, after they have attained good motor coordination, solicit nursing by briskly approaching the mare while tossing the head, laying back the ears, and sometimes nickering (Tyler 1969). If the mare is not standing motionless, the foal often passes in front of the mare pushing under her neck and into the nursing position. If the mare proceeds to move, the foal may again move in front of the mother as if to gain her cooperation and quiet stance. Similar circling and frisky motions are exhibited toward recumbent mares by care-seeking foals.

Foals position themselves along either side of the mare while nursing; yet, curiously, in some circumstances one side is favored more than the other. My students and I have noticed that within a box stall, young foals tend to nurse more often from the same side of the mare. Some prefer the left; others prefer the right. For example, one foal nursed 86 percent of the time on the mare's right while in the stall, but it showed no such position preference when nursing out-of-doors. Kownacki et al. (1978) noted that foals on pasture exhibited a 2:1 position preference.

Nursing during the day of birth is frequent and variable in length; but soon the bout duration becomes more constant, and frequency begins to decrease (see Figure 4.4). While nursing, foals exhibit a series of sucking bursts, then may pause, and may change teats between bursts (Francis-Smith 1978). Some pushing of the udder usually occurs. Nursing may last only seconds or for several minutes, but most observers report an average duration of 45 to 90 seconds. My data show that for the same foal, bouts were longer within the stall than outdoors on pasture. For example, one foal had an average nursing duration of 83 seconds in the barn compared to a 52 second average on pasture; another foal showed a mean duration of 88 seconds in the barn versus 50 seconds on pasture (Waring 1978).

The frequency of nursing and thus the total time spent nursing tends to decrease with age. During summer daylight periods, Feist (1971) observed foals of feral horses nursed nearly twice each hour, whereas the yearlings that were nursing did so only half as often. Tyler (1969) observed that newborn New Forest pony foals nursed an average of four times per hour. This decreased to twice each hour at six weeks of age, once each hour at five months, and once every two hours at the age of eight months. Kusunose and Sawazaki (1984a) also found the mean suckling interval increased with age under daytime pasture conditions (0830–1600); however, when the same horses were observed under nighttime conditions (1600–0830) in the stable, the mean suckling interval increased with age until 16 weeks but then ceased to increase further.

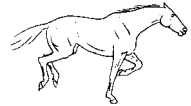
Nursing frequently is seen: (i) after periods of rest, (ii) following some separation of mare and foal, (iii) when the pair have been induced to change their location, such as being returned to their stall, and (iv) after disturbances which result in the foal seeking protection and comfort of the mare. Nursing can occur at any hour; yet peaks of nursing activity have been noted. Schoen et al. (1976) found a mid-morning as well as an early evening peak.

The termination of a bout of nursing can be caused by movement of the mare; yet, often it is the foal who terminates nursing. Feist (1971) noted in

the free-roaming horses he observed, foals terminated nursing in 75 percent of the bouts. Tyler (1969) reported similar findings once foals were past two months of age; however, especially in the first few weeks, mares terminated 30–45 percent of the bouts, primarily by moving away. When foals were less than a month of age, between 70 percent and 80 percent of the bouts were hindered because the mare continued to graze. Gradually this problem decreased. Biting was used by the mother to discourage nursing, especially in the fourth and fifth months, Tyler noted. Knocking and kicking were occasionally used to discourage foals from sucking.

Sucking responses of foals are not always exhibited for nourishment. Some non-nutritional attachment on a mare's teat appears to occur when comfort itself is sought. And foals occasionally suck elsewhere than on their mother. For example, Tyler (1969) observed several foals sucking teats of unbred older sibling fillies, and once a foal sucked for over two minutes from a 5-month-old filly. Another foal was observed to suck the sheath of a gelding. Ear sucking was noted by Houpt and Smith (1993).

10 Eliminative Behavior



The eliminative behavior seen in horses will nearly always involve either defecation or urination. Regurgitation is virtually non-existent; the closest being the feeble discharge of incompletely swallowed food or fluids caused, for example, by a blockage of the esophagus. In such instances, alteration of the horse's behavior is usually minimal. Urination and defecation, however, do occur with specific behavior patterns and are linked to social behavior as well. Thus the elimination of waste products is often more than a physiological discharge process; such activities frequently induce behaviors in nearby animals and tell much about the social and reproductive status of the individuals involved. When one horse eliminates, others in the social unit, especially adult males, often appear induced to also eliminate.

The amount of elimination per day as feces and urine reflects the intake of the animal in food and drink, as well as factors such as ambient temperature. The daily fecal output per horse tends to be 14–23 kg (30–50 lb). Normal daily urine volume can range from 3–18 ml/kg of body weight (Siegmund 1973). An adult Thoroughbred, for example, weighing 440 kg might have an average urine output of 183 ml/hr (about 1.2 gallons per day). Of the total water consumed daily with food and drink, only about 22 percent will be eliminated as urine; most water loss occurs in respiration, feces, and sweat (Spector 1956).

■ Urination ■

A horse about to urinate stops locomotion and assumes a basic posture where the neck is slightly lowered, the tail is raised, and the hindlegs are spread apart and stretched posteriorly (Figure 10.1). Foals, even neonates, attain the basic posture for urination. When positioning the hindlegs, horses

keep their hindlegs in place and step forward with the forelegs. In strong wind, horses often orient upwind. Females tend to spread their hindlegs more than males, and males tend to attain more posterior stretch of the hindlegs. In both sexes, a slight squatting motion is common during urine flow. A stallion when marking other excrement with his own urine often raises his tail well above the more horizontal position occurring in typical urination. The penis is commonly extended slightly for urination.

The urination sequence lasts approximately 10 seconds. After urination, the penis sometimes extends pendulously for a short time. In the female, urination concludes with a brief series of vulva contractions called winking, where the clitoris is repeatedly everted. Non-estrous mares and males return to a normal stance soon after urine flow ceases, sometimes switching the tail or shaking the body. Estrous mares tend to retain the urination stance momentarily with tail raised and the winking sequence prolonged.

While in estrus, mares may urinate frequently and in small amounts (<0.5 liter). Stallions intent on marking excrement also may urinate in small amounts as well as repeatedly. A stallion's discharge when marking is usually one or two relatively forceful squirts of urine.

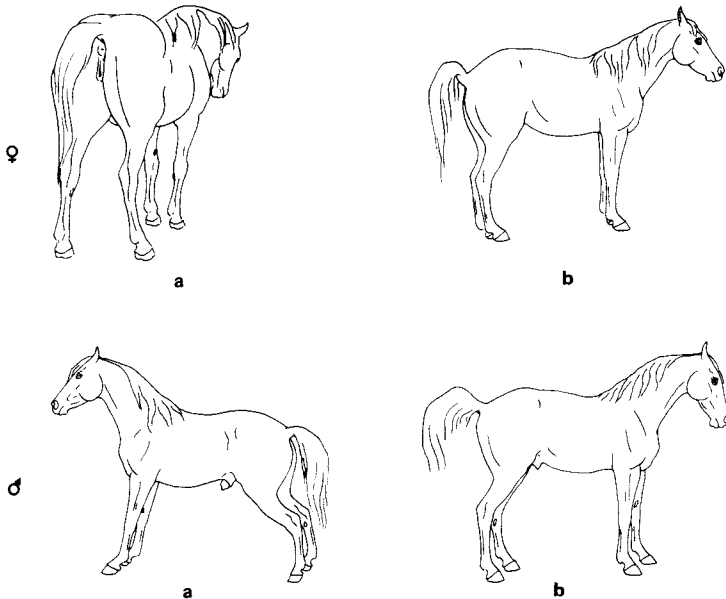


Figure 10.1: Eliminative postures of female and male: (a) urination, (b) defecation.

In foals, urination may begin during the third hour after birth and for several weeks recurs rather often. Jeffcott (1972) found colt foals first urinated at an average of 5.97 hours (range 2.75 to 8.0), whereas filly foals urinated at 10.77 hours (range 7.25 to 15 hours). During daylight, Tyler (1969) observed foals urinated hourly for the first two weeks before the interval gradually increased, stabilizing at one year at a frequency similar to adult mares. Adult mares were found to urinate an average of once every 3.8 hours in summer and every 4.5 hours in winter. In another population of horses under somewhat similar conditions, Kownacki et al. (1978) found mares urinated an average of 7.4 times in a 24-hour period, stallions 12.8 times, and foals 12.5 times.

During urination, grazing ceases in the majority of instances; yet no particular site is sought. The animal in most cases seems merely to pause momentarily during other activity or as a transition occurs, such as after resting and just before grazing.

Stallions during the breeding season are often quick to investigate a mare after she urinates. Interest in the mare, however, is not prolonged if she is not in estrus. Stallions often direct their attention to the eliminated material. Feist and McCullough (1976) noted stallions responded to 50.6 percent of the 77 observed urinations of adult mares. The typical stallion response was to approach, smell the urine, step over it, urinate on it, and finally turn and smell again. Flehmen sometimes occurred during olfactory investigation. Although stallions in this feral population did not respond quite as often (39.5 percent, $n = 76$) to defecations of mares, the behavior of the stallions toward the material was similar. Approach, investigation, and marking were done systematically as was the case with mare urine. Urination by a stallion rather than defecation occurred in 92.1 percent of the responses the males made toward the excrement of adult females as well as immatures of the herd. Young males, but no females, were occasionally seen to exhibit the response shown by adult males. Boyd (1980) witnessed young females in some instances also respond to excrement and add their own urine. In New Forest ponies (Tyler 1972), where comparatively few stallions were in the population, urination by adults onto feces was rare; the adult ponies were more inclined to add their own feces. Feist and McCullough (1976) noted that urination by feral stallions was uncommon (16.8 percent) on the communal stallion fecal piles. Dominant stallions otherwise showed a tendency to urinate on the excrement of subordinates.

■ Defecation ■

The process of defecation occurs without any specific posture except that the tail is raised and often held to one side (Figure 10.1). Many times horses do not cease locomotion or continue to graze while defecating. Yet if the animal does stop, it will typically first spread the hindlegs, then gradually raise its tail, protrude the anus, and finally commence elimination. The entire sequence seldom lasts more than 30 seconds, commonly less than 15. Some foals successfully defecate a few pellets before the end of the first hour after birth using a spread leg, tail-up posture. The neonatal foals Tyler (1969) observed seldom defecated, yet often strained, as if trying, when very young. The frequency of defecation increased with age (see Figure 4.8) and straining ceased after a few days.

After discharging feces, a horse steps forward and may switch its tail from side to side. If grazing or walking, it continues without interruption. Occasionally, however, the horse turns and sniffs the fecal pile. Olfactory investigation is more often seen when the horse has added fecal material to an existing pile. As with urination, stallions move to fecal piles and investigate them. Pawing of the material sometimes occurs before the animal steps over the pile and adds its own feces. A second bout of smelling concludes the marking routine.

The frequency of defecation can vary between sexes, age groups, and apparently with diet. Tyler (1969) found that during daylight hours New Forest ponies defecated on the average every 2.2 hours in summer and every 2.4 hours in winter. Kownacki et al. (1978) noticed eliminative behavior occurred somewhat uniformly throughout the 24-hour period in both sexes. In their study, defecation by stallions occurred an average of 12.8 times in a 24-hour period, in mares it was 6.5 times, and in foals 10.3 times in one day.

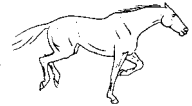
Horses in pastures not shared with other kinds of livestock commonly defecate more in certain poorly grazed areas than in areas heavily grazed. Pastures thus become partitioned into zones of short grasses as well as rough areas of tall grasses and weeds. Ödberg and Francis-Smith (1976) found the adult horses they observed spent most of their time in the short grass zones, but prior to defecation the horses would proceed to a nearby rough area, sniff the ground, defecate, and then leave the rough. Foals were less inclined to restrict defecation to the rough areas and even grazed the roughs.

Free-roaming horses tend not to limit defecation to certain areas, except for the stallions. Adult males (harem stallions as well as bachelor males)

often become preoccupied with visits to established fecal mounds; these are thus called stud piles. Of the 186 defecations recorded by Feist and McCullough (1976), a total of 89.8 percent occurred at stud piles. Sometimes younger males also used the piles. Such mounds occurred periodically throughout the range and were added to by any stallion that encountered them. The largest piles were those along the routes of a number of social units, such as along a common path to water holes. Feist (1971) found the size of stud piles ranged from less than a square meter to a series of adjacent piles of successive age as large as 1.8 by 7.6 meters. The piles were often used during encounters between stallions as part of their agonistic behavior pattern.

Stallions appear to limit the amount of fecal discharge when marking fecal piles or the dung of mares, thus repeated marking can occur in a short time. Tyler (1969), for example, saw one stallion defecate on three different piles and urinate on a fourth within a 10-minute period.

11 Comfort Behavior



Comfort behavior includes such activities as sunning, scratching, rubbing, licking, rolling, and shaking. In addition, I have chosen to include mutual interactions (such as allogrooming) and the behaviors horses exhibit to minimize the effects of storms, heat, and insect pests. Many of these behaviors occur more often at one time of the year than in another.

A degree of comfort is also achieved when horses regain the nearness of other companions after a period of separation or when a foal seeks the side of its mother when danger occurs. These behaviors are discussed further in other chapters.

Self-Indulgent Behaviors

Sunning

During winter months when the nights have been cold, horses on fair weather mornings seek sunny places to rest in the warmth of the direct sun rays. Each horse orients its body broadside to the sun to gain maximum exposure. Some horses stand relaxed with eyes nearly closed; others become recumbent and sometimes show signs of slow-wave sleep and even paradoxical sleep. Sunning can last for 30 minutes or more before a horse commences a different activity. Sunning is occasionally seen during other daylight hours, such as soon after a storm dissipates and warm sun rays reappear.

Shelter-Seeking

During storms, horses often seek ways to lessen the effects of the storm on themselves, especially in low temperatures. They usually cease feeding and stand with their neck lowered to nearly horizontal. Recumbency rarely

occurs during bad weather. In strong winds, horses stand with their hindquarters positioned into the wind, or they move to sites sheltered from the wind. Shivering sometimes occurs.

In hot weather, horses often rest in shady areas during the hottest period of the day. Sweating occurs. Prolonged periods spent in and around water may occasionally be for comfort from heat.

Horses also seek water to reduce the effects of insects. Keiper (1979a), for example, reported feral ponies on Assateague Island moved considerable distance into the water of shallow bays or stood in the breaking waves of the surf apparently to reduce biting insects. Locomotion, such as galloping, also occurs as an anti-insect procedure. Another technique is to seek the shelter of sites with low insect density. Duncan and Cowtan (1980) demonstrated that Camargue horses moved to sparsely vegetated or bare areas for resting during daylight in the summer. At such locations the attack by horseflies (tabanids) was reduced (see Hughes et al. 1981). The horses spent little time at such barren sites outside of the tabanid season or at night. During summer months Keiper and Berger (1982) found similar refuge-seeking, pest-avoidance behavior in the feral horses they studied. On Assateague Island, resting typically occurred on the beach, in inshore water, and on the mudflat portions of the inner-dune zone—all barren areas with higher wind velocities and fewer biting insects. In the Granite Range of Nevada, refuge from insects was gained by utilizing the highest portions of mountain slopes, ridge crests, and snow patches.

Licking

Licking is occasionally exhibited by horses. It is normally used to groom in and around the mouth, but it is also a grooming procedure on accessible parts of the forelegs, shoulder, and barrel to remove substances (especially fluids) that have soiled the body surface. Compared to many other mammals, equids make little use of licking to groom.

Nibbling

Nibbling with the incisors can vary from mild scraping of the skin with the teeth to a rapid nipping activity, where the skin is pinched repeatedly. It is a common form of grooming, apparently toward itching sensations and dried material in the pelage. Not all parts of the body are accessible to this behavior, thus nibbling can be seen primarily on the forelegs, sides, and loins (Figure 11.1a,b). A third of the self-grooming bouts observed by Crowell-Davis

(1987) in mares consisted of nibbling; for foals, nibbling accounted for 60 percent of the self-grooming bouts.

Somewhat related to nibbling is a hasty bite-like gesture toward the body surface—one of the anti-insect maneuvers of horses. The head is moved quickly toward the affected site and the teeth may make contact with the skin. Biting motions sometimes continue at that site, forming a bout of nibbling.

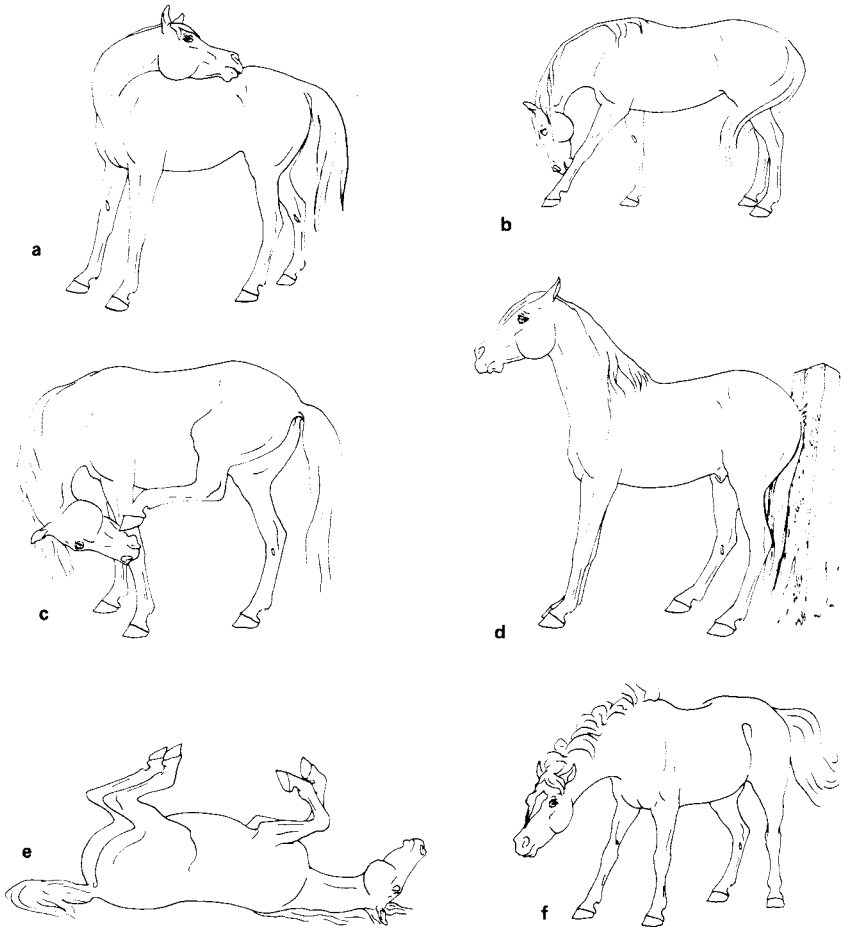


Figure 11.1: Examples of comfort behavior in horses: (a) nibbling, (b) nibbling at foreleg plus tail switching, (c) scratching, (d) rubbing, (e) rubbing back on substrate, and (f) shaking.

Scratching

The hindhoof is used by some horses to scratch the head and anterior portions of the neck. The behavior is common in foals yet rarely occurs in adults. Some mature ponies, however, retain the trait. In the Welsh ponies studied by Crowell-Davis (1987), scratching accounted for 17 percent of foal self-grooming bouts whereas for mares it accounted for 4 percent of the self-grooming bouts. Scratching with a hindleg is accomplished in a standing posture where the leg is raised and the hoof is rubbed against the head or neck (Figure 11.1c). The neck and head are lowered and usually turned toward the raised hoof.

Rubbing

Rubbing is where the skin is massaged either by another surface of the body or against some object in the environment. The muzzle is one part of the body that is often rubbed against the forelegs or barrel apparently in response to itching sensations. Crowell-Davis (1987) noted rubbing occurred in 42 percent of the self-grooming bouts of mares but in only 13 percent of the self-grooming bouts of foals. Often in adult and young horses, flying insects are brushed away with quick movements akin to a brief rub.

Hindleg movement (hindleg lift) is also used toward insects and other irritants along the belly. The leg is raised swiftly, and the stifle and medial portion of the leg are rubbed briefly against the flank and belly. The raising and lowering of any leg (i.e., stomping, knocking, and hindleg lift) to scare insects off the skin can vary from slight lifts to forceful contact of the leg against the belly or substrate.

Horses commonly use specific fixed objects in their environment for rubbing body regions, such as the head, neck, base of the tail, and buttocks (Hassenberg 1971). Oftentimes, the horse begins with rubbing the head and neck then proceeds to rub posteriorly concluding with the buttocks and base of the tail. Fences, door frames, posts, trees, and shrubs are often utilized as the fixed objects. The horse stands with its body touching the object and rocks back and forth rubbing a localized area of skin against the object (Figure 11.1d). Sometimes a horse will walk under low branches and let them rub the back. On other occasions, the animal may straddle a small tree or shrub and walk forward allowing the plant to rub its ventral surface. At times, horses in sternal recumbency rub the region of the sternum and lower neck by rocking forward and back against the ground.

Sexual stimulation may occur in mares that rub their buttocks, tail, and vulva against objects. Tyler (1972) noted how a mare involved in such rubbing would stretch her head, sway it from side to side, and quiver her

lips. Masturbation is also seen in stallions who rub their erect penis against their belly. Ejaculation sometimes occurs.

Rolling

Rolling is a specialized way of rubbing the back by utilizing the ground as the fixed object (Figure 11.1e). Rolling can accomplish other functions as well, such as dusting the pelage and for purposes related to social dominance. Many times rolling occurs at the conclusion of a period of recumbency; the animal rolls onto its back with all four legs skyward as it wiggles its back briefly against the substrate (Figure 11.2). More than one rolling bout may occur before the horse stands. In most cases, the horse does not roll completely over but returns to sternal recumbency on the same side. Rolling accounted for 13 percent of the self-grooming bouts recorded by Crowell-Davis (1987) for pony mares; for foals, rolling occurred in only 5 percent of the self-grooming bouts prior to weaning.

Some horses tend to roll at certain locations within their environment. The preferred sites are generally places with dry fine soil, sand, or in some cases mud. Yet rolling has been seen to occur on most substrates. Pawing of the site oftentimes precedes going down to roll.

Shaking and Skin Twitching

Shaking the whole body usually occurs immediately after rolling, once the horse has gotten onto its feet. Even without rolling, whole body shaking often occurs following a period of recumbency. The neck lowers to near or below horizontal, and the horse oscillates quickly the superficial musculature over much of the body, vigorously shaking the pelage (Figures 11.1f and 11.2i) and generally releasing a cloud of dust. Shaking often begins at the head and quickly spreads posteriorly as a wave of muscular contractions. Whole body shaking occasionally occurs at other times, such as after a saddle and blanket are removed and even while being ridden.

Head shaking can also occur, independent of whole body shaking. Shaking of the head and nearby neck happens in response to insects and other irritation around the face and ears. The direction of head shaking is basically rotational around the longitudinal axis of the body, causing strands of the mane and forelock to be flung about.

Skin twitching is the localized, rapid, oscillatory contraction of cutaneous muscles. It occurs primarily along the shoulder and forearm. Such quivering of the skin is induced by localized tactile sensations and is commonly used against biting insects attempting to alight or remain on the skin.

a.



b.



c.



Figure 11.2: Photographic sequence of a mare rolling onto her back, then getting up and shaking.

Continued on next page



d.



e.



f.

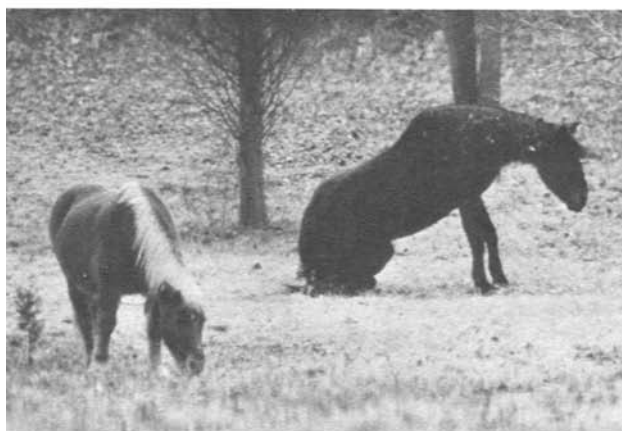
Figure 11.2: Photographic sequence of a mare rolling onto her back, then getting up and shaking.

Continued on next page

g.



h.



i.



Figure 11.2: Photographic sequence of a mare rolling onto her back, then getting up and shaking.

Tail Switching

Striking the body with the tail facilitates removal of insects from the hindquarters without the need for further action with either the head or legs. Thus while flying insects are present, horses have their tail in nearly constant motion flogging the thighs, hindlegs, and groin, wherever the pests attempt to land. The length of the tail governs the extent of its effectiveness in insect abatement. Foals and even yearlings cannot reach areas with their shorter tail that older individuals can.

The frequency of tail switching increases with increase in the density of flying insects. Ponies inhabiting Assateague Island were seen to average 54.8 tail swishes/min when inhabiting marshes, dunes, and inner-dunes; yet at less fly-infested sites (e.g., beaches and mudflats) 30.9 tail swishes/min were the average (Keiper and Berger 1982). On sunny days tail switching averaged 45.1 swishes/min; on cloudy days flies were less bothersome and the rate averaged 27.4 swishes/min; and on rainy days the rate was 19.7 swishes/min.

The motion of the tail is primarily from side to side allowing the long strands to strike and drag over the thigh and gaskin of both hindlegs (Figure 11.1b). Occasionally the swing is forceful causing the tail to lash the barrel or to move anteriorly through the groin. During comfort movements, the fleshy portion of the tail is raised minimally, seldom above horizontal. The tail rarely is lashed vertically to cause the strands to strike the area of the loins and croup.

— Mutual Interactions —

Mutual Grooming

Interactive nibbling between two horses is a common form of mutual grooming (allogrooming). Licking seldom occurs between two mature horses. The two partners usually face each other, standing so that one shoulder is close to the corresponding shoulder of the partner (Figure 11.3). Nibbling of the partner may be prolonged. Feist and McCullough (1976) found the duration ranged from a few seconds to 10 minutes, but in 90 percent of the occasions it lasted three minutes or less. After introductory sniffing, the grooming activity usually begins along the crest of the neck; it may then proceed to the withers, the shoulder, or along the back to the croup and base of the tail. Sometimes, the horses change sides.

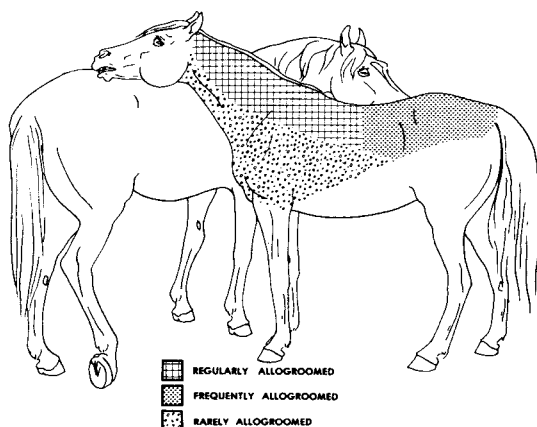


Figure 11.3: Mutual grooming (allogrooming).

Mutual grooming occurs primarily on areas of the body not easily reached during self-grooming activities. The dorsal portion of the neck and the withers are usual sites for nibbling. Hechler (1971) found preferences occurred in the following order for Icelandic horses: mane (59.2 percent), withers (18.5 percent), back (9.3 percent), croup (5.8 percent), tail base or dock (4.8 percent), neck (1.7 percent), and shoulder (0.7 percent). Feh and De Mazières (1993) analyzed video recordings of 38 allogrooming sessions to determine the preferred grooming site (base of neck anterior to the withers). Then the investigators experimentally groomed that site on other horses by manually imitating the scratching action and rate (2/sec). They found grooming at the “preferred grooming site” reduced the heart rate of the recipient horse, whereas grooming the shoulder (a non-preferred area) did not reduce heart rate.

Horses tend to establish one or a few regular grooming partners. Yet, some horses never seem to allogroom (Wells and Goldschmidt-Rothschild 1979). In free-roaming herds, mutual grooming is usually only among members of the same social unit. Allogrooming can occur between females, between males and females, and even between males. It is especially frequent among immature horses. The only combination where Feist (1971) did not see mutual grooming within social bands was between herd stallions and foals. A youngster may seek such interaction, but it is rare for an adult male to reciprocate. Foals tend to mutually groom with other foals (Crowell-Davis et al. 1986). Tyler (1969) observed that between any two partners, the more

dominant individual would almost always end a grooming bout; yet dominants initiated only 38 percent of the mutual grooming interactions.

In some cases, foals or yearlings approach their mother while she is involved in mutual grooming and proceed to nibble at her. The mare may ignore her offspring or commence nibbling of the youngster instead of the previous partner (Tyler 1969). Mares commonly lick their newborn foals for up to 30 minutes after parturition, but seldom does licking occur thereafter.

Several days after parturition, the mare and foal begin to allogroom. Previously, the foal's nibbling and chewing on the mare was not reciprocated. The earliest age for mutual grooming Tyler (1969) observed was between a 6-day-old foal and its mother. Blakeslee (1974) observed an 8-day-old and a yearling in a brief allogrooming bout. By a month of age, foals begin to spend long periods mutual grooming with other foals. This trend seems to increase over the next few months.

The frequency of mutual grooming among group members shows daily and seasonal variation. Keiper and Keenan (1980) noted mutual grooming decreased significantly between 2300 and 0400 hours on summer nights, corresponding to a period when recumbency increased. During the months of spring in southern France, May is the peak month for allogrooming among Camargue mares, stallions, and yearlings (Wells and Goldschmidt-Rothschild 1979). In England's New Forest, mutual grooming peaks in April and again in July; it is least frequent in September (Tyler 1969). April corresponds to the shedding of the winter coat, and in July the ponies congregate in the shade.

When grouped, the tail switching of horses serves a mutual function to fend off insects. Even pairs of horses occasionally stand side by side facing opposite directions while mutually switching the forequarters of their partners. Close body contact facilitates the tail action and reduces body surface exposure. Duncan and Vigne (1979) found horses have significantly ($P < 0.01$) fewer biting horseflies on them when they were in large groups and as a consequence fewer bites. Keiper (1979a) noticed an additional strategy; ponies while clustered and facing inward took turns circling the other horses using their tails and bodies to brush away insects.

Symbiotic Relationships with Birds and Humans

Mutualistic symbiotic relationships between birds and large animals, such as ungulates, exist on most continents. In such relationships, the birds either seek ectoparasites or obtain insects flushed by movements of the large animals. By eating ticks and biting insects or by scaring away pests, the birds

benefit their symbiotic partners. With horses, such a symbiotic relationship occurs primarily with the cattle egret. During horse-egret interactions, the birds sometimes feed while perched on a horse's back but more often while on the ground. Horses allow the activities of the birds and are not aggressive toward them. The overt passiveness of horses to the physical contact and intimate activities of the birds is evidence that the horses may receive some comfort from the relationship and control their agonistic responses accordingly. Similar passiveness is seen in situations where a horse recognizes a person is swatting and killing horseflies that have just landed or are already biting the horse; yet when such aid is not needed, the same horse may withdraw from human handling.

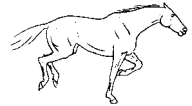
The mutualistic relationship between horse and mankind is the fundamental reason these two species formed an association some 6,000 years ago. Horses are capable of being amiable and generally tractable to humans plus provide us many benefits. In turn, horses receive protection, nutritional needs, and care from their owners.

Part IV



Reproductive Behavior

12 Sexual Behavior of Stallions



The stallion exhibits a variety of sexual behaviors, including being allured by a mare, testing the mare's receptivity, erection, mounting, intromission, pelvic thrusting, and ejaculation. When the animals are at pasture or free-ranging, the latter responses are seen less often than the behaviors leading up to mounting (e.g., see Zeeb 1958). Males at liberty are attracted to mature mares and often seem to search for receptive individuals; they test the mares encountered for olfactory, tactile, visual, and auditory cues of sexual readiness (e.g., see Tschanz 1980). Only occasional mares are receptive. The response of mares under such conditions is more often one of rejection. Only while in standing estrus will an unrestrained mare facilitate mounting and permit intromission. When not receptive, the mare will kick or show other signs of aggression as well as try to withdraw from the stallion. Most stallions thus determine the mare's receptivity with caution and become further aroused subsequent to positive feedback from the mare.

Under intensive management, the situation is usually different; a mare is commonly bred while in restraining harness, and the stallion is led to her. Prompt arousal and intromission are facilitated and encouraged. Stallions successfully achieving intromission and ejaculation under such circumstances become conditioned and soon exhibit sexual arousal, including penile erection, even before reaching the mare. Because the mare is usually restrained, testing activities by the stallion become greatly reduced, and the experienced male soon mounts. A stallion experienced at mounting a dummy (phantom) for semen collection generally becomes aroused by certain environmental factors, such as the approach of the artificial vagina or the presence of the dummy itself. Inhibiting factors can also develop and influence a stallion's behavior, causing impotence in one situation and not in other situations.

The physiological basis of stallion sexual behavior is complex. Beginning before birth, steroid hormones influence not only the development of internal and external reproductive organs but also the development of the male fetal brain. Masculinity is the result. Male sexual behavior involves testosterone and its metabolite estradiol, yet their role is involuted. Once the colt matures, exogenous and endogenous stimuli trigger or inhibit sexual responses by influencing brain tissue and neuroendocrine responses. To promote reproduction, GnRH (gonadotropin releasing hormone), released by neurons of the hypothalamus, is transported to the anterior pituitary via blood vessels and induces the release of LH (luteinizing hormone). In turn, LH is transported in blood plasma to the gonads where it stimulates the secretion of testosterone from the testes. GnRH also induces the release of FSH (follicle stimulating hormone) from the anterior pituitary; FSH is transported in blood plasma to the gonads where it, along with steroid sex hormones, regulates spermatogenesis. Usually hormones are released in minute amounts. The presence of one or more endocrine chemicals in the blood can induce other tissues to increase or reduce the chemicals they supply, thus the production and release of these substances are regulated by positive and negative feedback loops.

Seasonal photoperiod has some influence on the sexual cycle of stallions. For example, northern hemisphere stallions put on a 16-hour-light vs. 8-hour-dark photoperiod beginning on December 2, had larger testes, shorter time to ejaculation, and twice as much sperm output in February compared to other experimental treatments (Clay et al. 1987). Thus, photoperiod can be used to modify the seasonal sexual cycle of stallions.

The level of testosterone in the plasma of stallions is cyclic, varying seasonally and throughout the day. Byers et al. (1983) found testosterone levels highest in summer as well as in the afternoon (1400–1700) and at night (2200–0100); semen volume was found to be greatest in summer but total number of spermatozoa per ejaculate was highest in autumn. Thus, plasma testosterone concentrations are not necessarily associated temporally with optimum semen quality. Squires et al. (1981) injected stallions with testosterone propionate every other day for 88 days; they found libido was not affected by the treatment or its withdrawal. However, with the higher experimental dosage (200 µg/kg body weight), there was a reduction in scrotal width, spermatozoa production, number of sperm per ejaculate, spermatozoa mobility, and percentage of normal spermatozoa. By 90 days following treatment most of the adverse effects were gone; only the number of

spermatozoa per ejaculate remained low (but the number of spermatozoa in the extragonadal ducts was normal).

Patterns of Stallion Behavior

Pre-copulatory sequences usually begin with the stallion being attracted to a mare. One of the factors involved in attraction is the urination-like stance of a mare. The stallion may emit a brief whinny and begin a prancing approach holding his head in a collected manner with neck elevated and arched. The usual gait is a trot, with legs often flexed and extended vigorously. When the mare is among other horses, the stallion may lower his neck and extend his head aggressively to drive and separate the individuals, swinging his neck from side to side and threatening to bite.

As a stallion nears a potentially receptive mare, he often emits pulsated, guttural nickers. Upon reaching the mare, he begins to sniff her head, flank, genital area, and groin; oftentimes he nips the thigh or buttock of the mare. Occasionally, flehmen follows a bout of genital sniffing. Depending on the cues emitted by the mare, the stallion's interest may or may not continue. When the stallion's interest does continue, nibbling and licking of the mare's croup, hindlegs, neck, and forelegs are pre-copulatory activities which may occur as the stallion further tests the mare's receptivity and while the penis becomes fully erect (Figure 12.1).

Erection of the penis may begin as the stallion approaches a mare. The stallion has a vascular-muscular penis, with no baculum or sigmoid flexure. Successful intromission and insemination are dependent upon sufficient sexual excitement and complete erection. Foreplay and time for full arousal are necessary for successful horse breeding. Gradually increasing tumescence of the erectile vascular tissue of the penis causes protrusion from the prepuce, commonly called the sheath. At first, only the distal portion of the penis protrudes; at this stage, the proximal portion remains covered by the internal folding of the prepuce (Sisson and Grossman 1953). As penile engorgement progresses, the folding is eliminated and the tissues become relatively smooth as the shaft becomes firm. In mature stallions, the free part of the penis when fully erect is 30–50 cm long on the dorsal side. Usually full arousal of the stallion develops during the process of testing and tending a receptive mare. Repeated or prolonged flehmen, unsuccessful mounts, and withdrawal movements by the mare are among the factors that are associated with reduced stallion arousal and subsequent loss of erection.

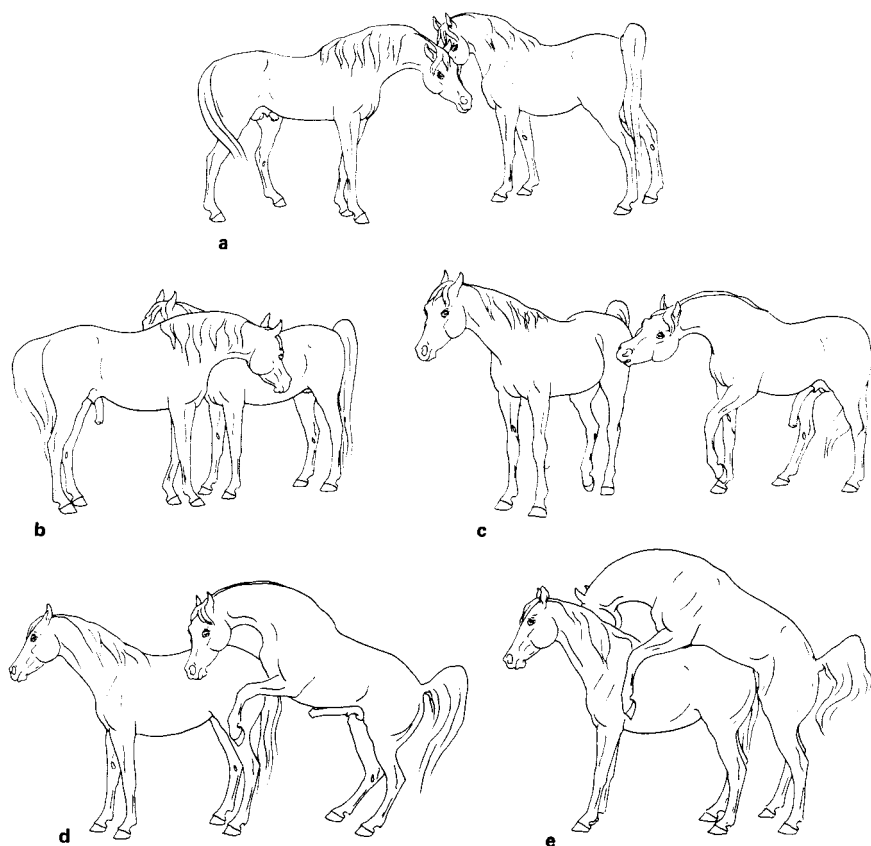


Figure 12.1: Sexual behavior sequence of stallion testing the receptivity of an estrous mare and becoming aroused. Mounting and copulation then ensue.

Sexual arousal manifested by erection of the penis occurs also at times when an estrous mare is not being tended—on open range as well as in confinement (cf. McDonnell et al. 1991). Mutual grooming, such as a stallion or colt with an anestrus mare, seems often to lead to an erection. Colts as young as 2 to 3 months occasionally exhibit full erection when resting or when interacting with other foals (Tyler 1972). Stallions while relaxed and undisturbed in a standing posture periodically exhibit erection and may repeatedly bob the engorged penis dorsoventrally (sometimes making contact with the belly) by rhythmical contraction of the ischiocavernosus muscles or rub the glans penis against the belly by rapidly lowering the croup. The sequence often ends after 1–5 minutes but may recur in an hour or two.

Occasionally, such masturbation results in ejaculation. Sometimes these events occur during lateral recumbency while in REM (paradoxical) sleep. Using nighttime videorecordings, Wilcox et al. (1991) studied 12 stallions; all showed some masturbation during the night. Ten became laterally recumbent and masturbated (in bouts averaging 14.5 min); 40 percent of the bouts occurred within 5 min after becoming laterally recumbent.

In stabled stallions observed by Tischner (1982) continuously for seven days, erection (partial or full) per animal occurred on average 7.4 times in 24 hours (range 3–17), with mean total time of erection being 38 min per 24 hours. Comparing winter observations to summer observations, Tischner et al. (1986) found each stallion exhibited full erection an average of 3.8 times per day in winter and 4.0 times in summer. Total erection time was greater in summer than in winter, and it was highest in the morning (0700–0900) and least following a period of exercise (1700–2000). More than 50 percent of the full erection time was spent in apparent masturbation. Three of the seven stallions observed were 9–10 years of age and the remainder were 1.3–2.1 years. Individuals did vary, but no statistically significant differences were noted in frequency of sexual reactions between young and older stallions. One older stallion had more frequent erections than the others and for longer periods. Masturbation with ejaculation occurred in two younger stallions (a total of 3 occasions) during winter observations whereas in the three older stallions (a total of 8 occasions) in summer.

In sexual encounters where the male has proceeded through some pre-copulatory behavior to test the mare's receptivity and has achieved erection, mounting is commonly attempted (Figure 12.1). The stallion normally mounts from behind the mare using a sudden rearing motion with forward shuffling of the hindlegs, places his forelegs along either side of the mare embracing her flanks or sides, and rests his sternum against her croup or back. Usually the neck is lowered allowing his mouth to rest against the mare's crest or alongside her neck. Biting of these areas sometimes occurs. Young males sometimes mount from in front of the mare or along the side and may proceed to then move their hindlegs behind those of the mare.

Pelvic thrusting and intromission may or may not occur during mounting. Tyler (1972) found that when free-ranging pony stallions mounted receptive mares, intromission was achieved during the first mount in 55 percent of the copulations; if initially unsuccessful and the mare remained stationary, intromission was usually achieved upon the second mounting

attempt. Some stallions initiate mounting before becoming sufficiently erect and thus more than one mount is required to achieve intromission. Young or impotent stallions after mounting may show little or no thrusting. Repeated thrusting is an important behavioral response required of the stallion to enable the penis to locate and penetrate the vaginal opening, achieve full intromission, and subsequently facilitate ejaculation. Erection of the glans penis becomes maximal once intromission is achieved, and several pelvic thrusts usually occur before ejaculation. Asa et al. (1979) found an average of seven thrusts occurred prior to ejaculation.

Ejaculation of semen usually begins 9–16 seconds after achieving full intromission. Pelvic oscillations cease just prior to ejaculation, and the concave, basin-shaped glans penis is held tightly against the end of the vagina and the cervix. Semen is forcefully ejaculated directly into the uterus (Walton 1960; Waring et al. 1975). The cessation of thrusting is an external sign of the start of ejaculation. As ejaculation proceeds, some muscles of the hindlegs may show iterative contractions. In addition, the tail commonly begins a series of up-down, flexing motions (tail flagging) in synchrony with and apparently induced by rhythmical shrinking of the urethral musculature. The ejaculate consists of 6 to 9 spurts or jets resulting from contractions of the urethra (Kosiniak 1975). The respiration rate is high. Immediately following ejaculation the stallion's body relaxes, and the head droops beside the mare's neck. About 30 seconds after copulation first begins, most stallions have achieved ejaculation and begin to dismount. Tyler (1972) observed copulation times of 12 to 26 seconds in New Forest ponies. Pickett et al. (1970), using young Quarter Horse and Thoroughbred stallions, recorded copulation durations of 14 to 43 seconds (mean 27.9 ± 7.7 SD). As the stallion dismounts, the penis has begun to become flaccid and withdraws easily from the mare. Within a minute, the penis has retracted into the sheath.

A generalized summary of the response times of various stallion sexual behaviors is provided in Table 12.1. Age, experience, season, and probably genetic background cause variation in such data.

After dismounting, the stallion commonly stands quietly behind the mare. He may yawn, stand relaxed, or begin to graze. He typically sniffs the genital region of the mare or the ground below. Flehmen may occur (Feist 1971; Tyler 1972). After several seconds, the pair then begins to separate. Tyler (1972) found the mare first moved away in 60 percent of the cases and the stallion, in 26 percent; simultaneous movement occurred in 14 percent of the separations. On a few occasions, the mare followed the stallion when he moved away.

Table 12.1: Sexual Responses of Stallions

Behavior Response	Young (mean)	Adult (mean)
Latency of erection ¹ (sec)	163	119
Latency of mounting ² (sec)	206	101
Latency of copulation ³ (sec)	415	211
Latency of ejaculation ⁴ (sec)		
Natural mating	11	13
Artificial vagina	—	16
Copulation duration ⁵ (sec)		
Natural mating	—	15
Artificial vagina	28	—
Latency of dismounting ⁶ (sec)	—	8
Number of mounts per ejaculation		
Natural mating	5.7	1.4
Artificial vagina	—	2.2
Maximum number of ejaculates		
In 24 hours	—	11
In 2.5	—	9

¹Interval between stallion first seeing mare and full erection.

²Interval between stallion first seeing mare and first mounting.

³Interval between stallion first seeing mare and intromission.

⁴Interval from intromission to first emission of semen.

⁵Interval from intromission to withdrawal.

⁶Interval from ejaculation to start of dismount.

Data from Wierzbowski (1958; 1959), Nishikawa (1959), Bielanski (1960), Tyler (1969), and Pickett et al. (1970; 1976); adapted from Waring et al. (1975).

Intensity of Sexual Behavior

Libido occurs throughout the year in stallions; nevertheless, the sex drive (as evidenced by reaction time) is greater in the spring than in autumn or winter. The intensity of stallion sexual behavior thus coincides with the breeding season of mares. If permitted, a stallion may copulate several times in one day; yet, sexual satiation does occur. Bielanski and Wierzbowski (1962) found stallions lost further sexual drive for the remainder of a day after 1–10 ejaculations; the average for their study was 2.9 ejaculates to reach satiation. A free-ranging stallion observed by Tyler (1972) attempted copulation ten times in one day, i.e., two attempts on each of five estrous mares. Six of the copulations were successful with three of the mares. No success was achieved with mounts of two other mares. In addition, the stallion ignored the frequent

solicitation of two 3-year-old mares during the same six hour period (1020 to 1615 hours in late April). Although adult stallions may retrieve young mares in estrus, sexual interest toward such mares typically is low.

The latency of mounting, number of mounts per ejaculation, and seminal characteristics of stallions vary seasonally. Pickett and his co-workers (1976) collected each week for 13 months two ejaculates at a one-hour interval from each of five Quarter Horse stallions. The number of mounts required for the first ejaculate did not differ from the number of mounts required for the second ejaculate collected an hour later. Nevertheless, during fall and winter months the number of mounts required for either ejaculate increased significantly compared to the spring and summer months (Figure 12.2). The reaction time from first visual contact with the mare until copulation started also markedly increased in the fall/winter period. In an earlier study (Pickett et al. 1970), the investigators found the copulation time, from entry into the artificial vagina until the start of the dismount, did not change seasonally.

Age and sexual experience affect male sexual behavior. Colts in their first few weeks of life begin to show mounting attempts. Full erection of the penis occurs in the first month and can be common by the third month. Rarely do young colts exhibit erection or pelvic thrusting while mounting. An exception was observed by Tyler (1972) where a 2-year-old estrous filly became the center of attention of a 3-month-old colt. The colt sniffed and nibbled the filly. When she spread her hindlegs and raised her tail, the colt mounted with erect penis and made numerous pelvic thrusts before dismounting. The pattern recurred repeatedly for an hour. Because of the colt's small size, intromission was not achieved.

As colts develop (especially from the age of two onward), they begin to show great interest in estrous mares. They sniff, nibble, and attempt to mount. Although young inexperienced mares are often tolerant, adult mares rarely allow colts to mount. The aggressive behavior of stallions and adult mares normally prevents young males from attempting copulatory behaviors, except with mares younger than 4 years. Harem stallions usually do not show sexual interest in such young mares of their band even when the young mares solicit during estrus.

Full growth and maturation of the male reproductive system requires several years. Spermatozoa first begin to appear in the testes at 12–16 months of age (Warnick 1965). Prior to 24 months of age, most colts have low fertility. Naden et al. (1990) used number of spermatozoa per ejaculate to demarcate puberty; they concluded the average colt was 83 weeks (range 56–97 weeks) before reaching the required 50 million spermatozoa with ≥ 10 percent motile.

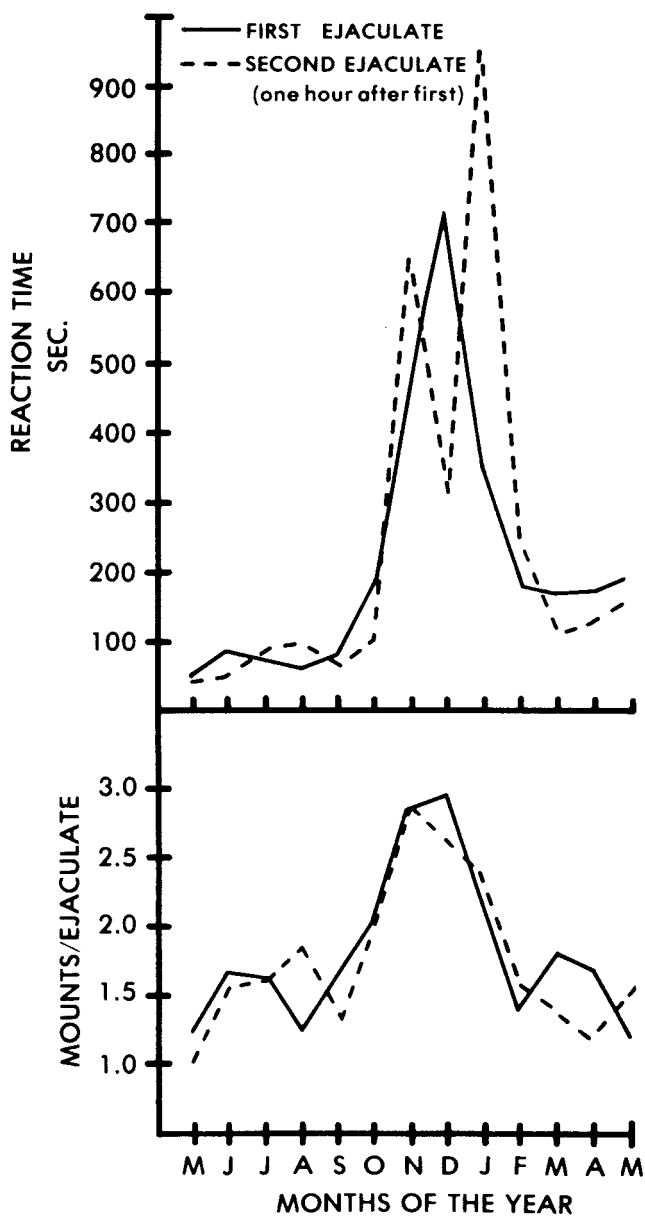


Figure 12.2: Seasonal change in reaction time and number of mounts required to collect first and second ejaculates from stallions in Colorado. Reaction time was measured as the interval from first visual contact with the mare until the start of copulation. (After Pickett et al. 1976)

Fertility typically improves over the next 2 to 5 years. Thus even without social and environmental inhibitions, the reproductive role of young stallions is not likely to begin before their third summer. To become a harem stallion requires additional years of social and physical development. Only then can a stallion achieve the greatest reproductive success (Asa 1999).

Young stallions, although possessing a high libido, lack breeding efficiency compared to experienced stallions. Wierzbowski (1959) determined the latency of erection and of mounting of young and adult stallions. The adult stallions required less time to achieve full erection after first seeing a mare. Furthermore, the average interval between first seeing the mare and first mounting was much shorter for the more experienced adult stallions, 101 seconds compared to 206 seconds for the younger group. Not only are young stallions slower to mount, they also tend to require more mounts to achieve ejaculation.

With advancing age, stallions often retain their sex drive yet have declining fertility. Under management conditions, some stallions over 20 years of age are successfully used for breeding. Nevertheless, infertility becomes more prevalent in stallions over the age of ten. Libido is not a useful measure of fertility. In some cases, fertile stallions show little sex drive because of one or more traumatic experiences associated with mating.

Stallions experienced in breeding may retain interest in mares and exhibit sexual behavior subsequent to castration. Nishikawa (1954) noted castrated adult stallions maintained normal sexual desire for 516 days after surgery. Early gelding, however, usually yields a male with greatly reduced intensity of normal male sexual behavior. Nevertheless, Line et al. (1985) found 20 to 30 percent of geldings castrated before 2 years of age displayed stallion-like sexual behavior and aggression toward horses. This percentage was not significantly different from the occurrence of these behaviors in males gelded when over 3 years of age. Thompson et al. (1980) found libido and the ability to ejaculate were gradually lost after castration but that testosterone treatment restored libido and the ability to ejaculate within two weeks. By contrast, their higher-level estradiol treatment restored libido but was not very effective in restoring the ability to ejaculate. McDonnell et al. (1989) found GnRH treatment alone had no apparent effect on the sexual behavior of geldings.

Contrary to popular belief, there is no evidence to suggest that sexual behavior following castration is related to the presence of epididymal tissue (Crowe et al. 1977). Geldings displaying sexual interest in mares as well as aggressive tendencies can have testosterone and estrogen levels equal to

geldings not showing such studdish behavior, according to Voith (1979b). Incomplete castration sometimes may be involved in cases where sexual behavior is retained. For example, castration of cryptorchid males can be difficult and occasionally only the tail of the epididymis is surgically removed without removing testicular tissue (Trotter and Aanes 1981). Testosterone production thus remains high. Subsequent removal of a retained testis usually diminishes sexual behavior.

Stimuli Affecting Stallion Sexual Behavior

Visual stimuli initially attract stallions to mares. The urination-like posture of a mare with hindlegs spread and tail raised seems especially effective. Frequent urination is characteristic of estrous mares as is the prolongation of the stance while showing vulval winking. During winking the clitoris is repeatedly everted on a rhythm of approximately once per second exposing light-colored membranes normally covered by the dark labial tissue. Beyond a distance of a few meters, winking appears as a bright-spot flashing against a dark background.

Mares do not appear to utter any sounds to attract stallions. The splashing sounds that occur during urination may, however, attract a stallion's attention.

Some stallions reject certain mares and are sexually attracted to others. Coat (pelage) color is one of the factors which may be involved. Feist (1971) noted two feral stallions in the same vicinity each sought and had in his band only mares of buckskin coloration, while a third harem band had only sorrel and bay mares. Age of the mare is another factor. Harem stallions are more attracted to full-grown mares than younger mares. When a stallion is presented with more than one mare in estrus, he tends to select the dominant mare for copulation (Asa et al. 1979).

Once attracted, the stallion seeks additional signs to test whether the mare is receptive. Visual stimuli, such as the mare's actions, continue to be involved. Estrous mares are more passive and raise their tails; non-estrous mares will usually threaten using laid back ears, bite or kick threats, as well as squealing sounds. Olfactory investigation of the mare's urine and genital region suggest odor cues further influence the stallion's sexual behavior. Young stallions usually respond little to phantoms; yet when a dummy is sprinkled with urine from an estrous mare, erection and mounting responses increase (Wierzbowski 1959).

Tactile contact with a mare by nuzzling and nudging her with his head and forequarters, concurrent with positive feedback from visual and olfactory investigations, arouse the stallion so that erection develops. Inhibitory stimuli such as visual and acoustical threats by the mare, harsh tactile stimuli, and perhaps certain odors impede the progression of male sexual behavior; arousal then wanes.

In the stallion, the modification of sexual responses to visual and other stimuli can occur through learning. Stallions experienced with semen collection routines often become aroused by environmental factors other than just the mare or mounting dummy. Stallions having experienced unpleasant events when mounting or copulating may react negatively to subsequent breeding situations when a similar environmental context occurs. Among the factors involved in facilitating or inhibiting stallion performance are the site of breeding, the behavior of the mare, her size and color, dummy size and shape, handlers and handling procedures, nearby animals, and the apparatus utilized. Often the alteration of a stallion's response is situation specific. In a new environment, the response may be quite different.

The complex interaction of facilitating and inhibiting stimuli in the sexual behavior of stallions was demonstrated by Wierzbowski (1959). Stallions were tested for their reaction to a dummy and a cow as a mounting partner. Unless a phantom was treated with estrous mare urine, young naive stallions showed no response to a dummy; although when blindfolded, some of the young stallions (9 percent) showed a mounting response. Sexually-experienced stallions without sensory impairment exhibited a rather high response rate (79 percent) to a dummy; when blindfolded, sexually-experienced stallions responded much less (38 percent). If presented with a cow when both visual and olfactory stimuli were impaired (using a blindfold and a nose mask containing trichloroethylene), erection and mounting responses both occurred in the three stallions tested. When other tests were conducted with only a blindfold, some sexual interest occurred upon contacting the cow. Yet when the stallions had no sensory impairment or when only the nose mask was applied, the stallions showed no sexual interest in the cow.

After intromission is achieved, tactile receptors along the surface of the penis respond to pressure of the vagina as well as to tactile stimulation caused by thrusting. Erection becomes maximum and ejaculation begins after several seconds.

Erection is, of course, necessary for successful intromission; nevertheless, erection is not essential for ejaculation. Pickett and his co-workers

(1977) collected normal semen quantity and quality from impotent stallions using artificial vaginas. The stallions eagerly mounted mares and exhibited normal pelvic thrusts, copulation time, and ejaculation; yet, in these cases, no erection occurred.

Semen collection is most readily done using an artificial vagina (AV) while the stallion mounts a dummy or tease mare. Manual-stimulation collection is also possible resulting in ejaculate characteristics similar to AV collection (McDonnell and Love 1990). Electro-ejaculation is of little success with stallions. Compared to cattle, the ejaculatory response of the stallion is not as sensitive to temperature. However for prolonging the life of the spermatozoa as well as stallion comfort, Pickett (1974) recommended an initial AV temperature of 44°–48°C. Dowsett and Pattie (1980) found success with an initial AV temperature of 50–52°C, to have a mean post-collection AV temperature of $44.6 \pm 2.2^\circ\text{C}$.

Abnormal Sexual Behavior of Stallions

Abnormalities in the sexual behavior of stallions range from excessive biting and aggressiveness to the various forms of impotence and even fear of mares. Sometimes pathological causes or even congenital malfunctions are involved; yet in many cases, psychogenic factors are responsible for or contribute to aberrant sexual function and behavior. A stallion can acquire a severe inhibition toward sexual activity because of injury or psychological trauma during previous situations. Thus in cases where management procedures, pain, or unpleasant experiences have contributed to sexual abnormalities, some degree of reversibility of the acquired trait is often possible. Most patients respond well to retraining, and recoveries usually require no treatment with drugs (Pickett et al. 1977). McDonnell et al. (1985) experimentally demonstrated sexual dysfunction can result from negative experience and that diazepam (an anxiolytic benzodiazepine derivative) was effective in restoring sexual function. They also found that when a stallion is in a novel environmental situation erection is slower to occur and not maintained; diazepam, however, blocks such effects (McDonnell et al. 1986).

Impotence in stallions, that is the inability to successfully achieve copulation and ejaculation, can be exhibited in the following ways (Pickett et al. 1977): (i) failure to obtain or maintain an erection, (ii) incomplete intromission, (iii) lack of pelvic thrusts after intromission, (iv) dismounting at the onset of ejaculation, (v) failure to ejaculate in spite of repeated

intromissions with complete and prolonged erection, and (vi) normal arousal and ejaculation yet, in spite of high libido, they cannot ejaculate normally again without prolonged sexual rest.

Not all cases of impotence can be detected from afar. For example, intromission can occur and using behavioral indicators it may appear as if ejaculation occurs; yet, palpation of the urethra during copulation may be necessary to detect that ejaculation is not occurring for a stallion having a history of poor reproductive success. The fertility of such a stallion is normally questioned long before consideration is given to the possibility of impotence. Thus, proper diagnosis is important.

The diagnosis and treatment of a stallion for impotence may require a variety of tests and procedures. Libido, erection, intromission, thrusting, and ejaculation must each be evaluated. Semen collection using an artificial vagina and subsequent seminal evaluation is advisable to determine semen quantity and quality. The stallion's sex drive and behavioral patterns should be checked with several different mares in estrus. The stallion may show a preference toward mares of only a certain size or color or show interest only within a limited time of year. During examinations, the rapidity and extent of erection and other sexual responses can be evaluated. The presence of other stallions, additional horses, or particular handlers may facilitate or inhibit the stallion's responses and should be checked. Some stallions are inhibited in one situation but not in another. Stallions showing fear or extreme aggressiveness may require evaluation using a phantom. Impotent stallions should also be observed for evidence of masturbation, and whether it is a factor in the stallion's reproductive problem. In general, a thorough review is needed of the stallion's health, handling, and breeding background.

Pickett et al. (1977) recommended the following questions when diagnosing abnormal sexual behavior:

- a) What is the stallion's breeding history?
- b) What type of breeding program is used (i.e., pasture, hand mating, or artificial insemination)?
- c) Does the stallion's sex drive appear normal?
- d) What was the stallion's sexual behavior prior to the onset of the abnormal pattern?

- e) Has the stallion been observed masturbating? If so, what treatment, if any, has been initiated in an effort to control it?
- f) How many mounts are generally required per ejaculation?
- g) Does the stallion dismount at the onset of ejaculation?
- h) Does he show preference for certain mares, such as mares of a particular color, stage of estrus, and so on?
- i) Does the stallion object to breeding certain mares?
- j) Has he been injured or frightened during teasing, mating, or while exhibiting aggressive sexual behavior?
- k) Has any scrotal swelling been observed?
- l) Has the stallion experienced pain or discomfort during mounting, copulation, ejaculation, or upon dismounting?
- m) Has the stallion ever had laminitis or other forms of lameness causing difficulty in mounting?
- n) Has he had surgery, recent illness, or exhibited any kind of unusual behavior patterns?
- o) What drugs have been administered?
- p) How frequently was the stallion used for breeding as a 2- or 3-year-old, and how frequently has he been used this season or the season the problem was first noted?
- q) What methods of discipline are used, and when are they used?

Inhibition of sexual behavior may require much work to overcome; yet the alteration of certain environment conditions, such as a change in handlers, breeding site, or methodology, may achieve success without the need for reschooling. For example, Veeckman (1979) reported the refusal of a stallion to mate mares during the first postpartum estrus (foal heat) was overcome by rubbing fresh feces of the stallion on each mare. During subsequent estruses, the mares were bred by the stallion with few difficulties. Sometimes the faulty application of an artificial vagina inhibits a stallion, whereas another technician has no difficulty collecting semen from the same stallion.

The problem of failing to obtain or maintain an erection can be more than a situation of the lack of libido. Stallions with very high libido as well as those with little sex drive may have this problem. The experiencing of severe genital injury or other trauma during sexual behavior is often involved in this syndrome. Pickett et al. (1977) described some examples they examined. One stallion had reportedly experienced penile paralysis three years earlier following the administration of a tranquilizer. When tested, the stallion in the presence of an estrous mare showed interest in mounting and, once mounted, achieved ejaculation; yet the penis was not erect and protruded only 15–20 cm. Another stallion who had been kicked on the penis by a mare during mating also would not attain an erection. The stallion would tease effectively as well as mount and thrust normally. However, in this case, massage therapy was initially needed to induce ejaculation; yet the penis remained flaccid.

Imipramine hydrochloride treatment can induce sexual arousal in mature male horses. McDonnell et al. (1987) administered imipramine to five adult males (two were normal breeding stallions, one was an inexperienced young stallion, one was a long-term castrated male, and one 5-year-old was dysfunctional for erection and ejaculation). Oral as well as intravenous treatment induced similar results in all five individuals. Full erection typically occurred within 10 minutes; masturbation ensued. Erection and masturbation continued intermittently for 1 to 2 hours; two stallions ejaculated while masturbating. Environmental disturbances, such as the approach of a handler, temporarily disrupted the sexual activity.

In stallions maintained for breeding, masturbation is usually considered and treated as a problem behavior. Frequent masturbation may reduce sexual drive and cause the stallion to refuse to mount mares. Stallions that are adjusted to the breeding procedure will not normally masturbate with sufficient frequency to reduce libido (Pickett 1974). A stallion ring is commonly used to prevent masturbation. It is usually effective when properly fitted and must be removed before breeding. The ring, often made of plastic, is fitted over the end of the flaccid penis about three centimeters above the glans. When properly applied, urination is not inhibited, but the constrictive force the ring causes upon penile enlargement effectively discourages erection. Occasionally other devices, such as restrictive cages applied around the glans or wire brushes harnessed below the belly, have been used to irritate the penis when the stallion tries to achieve full erection or to masturbate.

Incomplete intromission or lack of pelvic thrusts after intromission can be caused by poor libido as well as by prior injuries or pain associated with breeding. Discomfort associated with laminitis or a persistent injury can sometimes be involved. Overuse of stallions at 2 and 3 years of age seems also to result in this problem (Pickett et al. 1977). A hereditary basis for incomplete intromission and lack of thrusting has been suggested by Hafez et al. (1962).

Dismounting at the onset of ejaculation seems associated with stallions that have good libido but a past experience of injury during copulation. A stallion treated by Pickett et al. (1977) had suffered a severe shoulder injury inflicted by a kick from another mare while the stallion was mating. Although subsequently aroused while a teasing bar or fence separated him from a mare in estrus, the stallion would show indifference to mares when in direct contact without such protection. After his confidence was partially restored around a mare, the stallion proceeded with sexual behavior yet would dismount at the onset of ejaculation. Several more weeks of additional retraining with a mare were required to return the stallion's behavior to normal.

Failure to ejaculate in spite of complete erection and energetic intromissions is occasionally reported and may have an organic or psychogenic basis (Figure 12.3). In some cases reported by Pickett et al. (1977), prior injury during copulation appeared to be a major factor inhibiting the stallion's response. Other cases, however, seem to have as a basis a previous spinal injury or some inhibition caused by handlers or tack during hand breeding. Rasbech (1975) treated six stallions with drugs when alteration of environmental conditions, including number of mares served, failed to correct ejaculatory disturbances. Two of the stallions subsequently recovered normal sexual function; one had been treated with several doses of pilocarpine, and the other, with repeated doses of ephedrine.

Some stallions show normal sexual behavior for awhile but fail to ejaculate, although their sexual drive remains high. Some Belgian stallions have shown such an abnormality, especially at the peak of the breeding season (Vandeplasseche 1955). Sexual rest of several days normally returns such stallions to full potential only to see a return of the problem when a frequent breeding schedule is resumed. The number of mounts required to achieve ejaculation greatly increases as the problem returns. The underlying cause is not always apparent. Recurring discomfort during copulation or inappropriate handling may be involved.

Excessive aggression is an aberrant behavior problem of some stallions. Frustration of high-libido stallions caused by incomplete sexual interactions and repeated non-ejaculatory copulations appears involved in most cases.

EJACULATORY DISORDERS

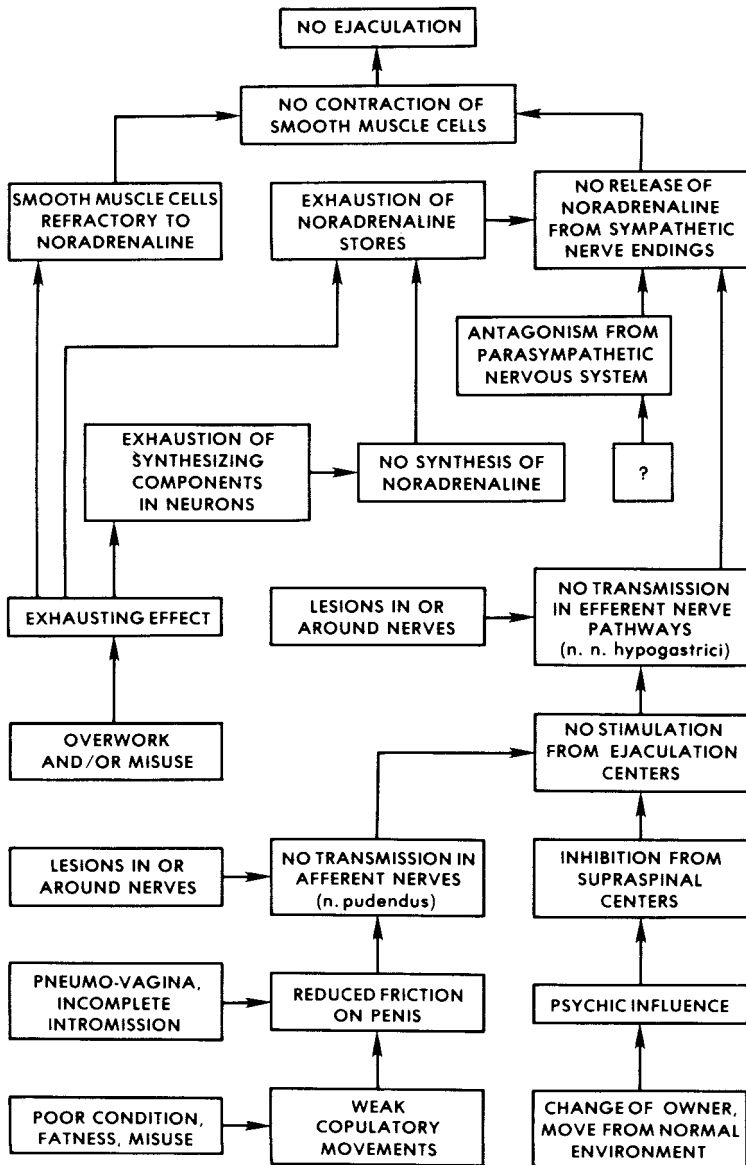


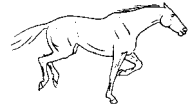
Figure 12.3: Interaction of environmental, behavioral, and physiological effects in ejaculatory disorders. (Adapted from Rasbech 1975)

Tyler (1972) noted that in the spring, stallions recently turned out to the New Forest from winter confinement attempted to mount and copulate even non-estrous mares. The stallions became increasingly aggressive and in some cases attacked young mares and even fatally mauled foals. Stallions that copulate vigorously but fail to ejaculate often become increasingly aggressive. One older stallion reported by Pickett et al. (1977) attempted to bite, kick, and strike mares after non-ejaculatory copulations developed. The savage attitude was even shown toward a phantom. The stallion's attitude became progressively worse until on one occasion he was permitted to charge the phantom and fell. When immediately presented to the phantom again, he mounted cautiously and ejaculated into an artificial vagina. Normal behavior and ejaculation were maintained with the phantom during the next two weeks. Subsequently, the stallion was returned to the owner and used successfully to breed mares.

During the non-breeding season, Pickett et al. (1977) observed that there is a greater tendency for certain stallions to excessively bite and strike mares prior to and during copulation. The effect of season on the number of mounts and the time needed to achieve intromission was also most pronounced for those stallions.

Besides the sometimes imprudent use of stallions for breeding or semen collection during the fall and winter, Pickett (1974) identified additional management practices as potential causes of altered sexual behavior. These are: (a) overuse of stallions of 2 to 3 years of age, (b) unduly rough handling of stallions during breeding and not permitting some aggressiveness, (c) isolation of stallions from other horses during the non-breeding season, (d) using a stallion excessively as a teaser, and (e) forcing the stallion to breed a mare when he shows considerable objection. Young stallions are especially vulnerable to the effects of early experiences in breeding. Pickett et al. (1977) recommend that a mare be hobbled and twitched to prevent kicking injuries to a stallion and that young stallions be introduced to the breeding routine gradually over a period of several weeks.

13 Sexual Behavior of Mares



The reproductive phase of a mare's life begins at puberty and continues for many years into old age. Chemical messengers secreted into the blood by endocrine cells or by specialized neurons participate in the control of the female's reproductive physiology, as in the male. Gonadotropin releasing hormone (GnRH) from the hypothalamus is one of these substances; it induces secretion of follicle stimulating hormone (FSH) plus luteinizing hormone (LH) from the anterior pituitary. In the ovaries, LH promotes secretion of estrogens and FSH induces follicle development. These and other important substances ebb and flow characteristically during the mare's reproductive cycles, regulated in part by feedback loops.

A young mare's first estrus, the period of sexual solicitation and receptivity, occurs between 8 and 24 months of age. The event is used as a sign that puberty has occurred. Under management conditions with good nutrition, fillies normally reach puberty in 12 months (Ginther 1979). Jaworowska (1981) found forest-dwelling fillies in Poland normally reached puberty and became pregnant when 12 to 16 months of age. However, under some open-range conditions, many mares are in their third spring or summer before they exhibit estrus. Harem stallions tend to ignore the solicitations of these young mares. Mating with young stallions does occur, but conception is low. In Tyler's study (1972), one mare out of 107 foaled when 2 years of age (0.9 percent), and only 14 out of 104 of the 3-year-old mares foaled (13.5 percent).

Well-fed fillies seem to breed earlier. Comparing fillies reared on different quality home ranges, Berger (1986) found all three females from high-quality areas produced foals at two years of age, 1 in 6 of those from medium-quality areas had a foal at two years, and none of the females from poor-quality areas produced offspring before the age of three.

Breeding and foaling tend to occur at a time of year when food supply and other environmental conditions are optimum for the development and survival of the foal, including gestation and lactation success. Reflecting the seasonal breeding pattern, most foals are born during the spring after a gestation of slightly more than eleven months.

Patterns of Mare Behavior

Mares are generally considered seasonally polyestrous, cyclically showing periods of diestrus (sexual quiescence) and estrus during the spring and summer then a prolonged anestrus (where the reproductive physiology goes dormant) in the late fall and winter. During the breeding season, the estrous cycle recurs approximately every three weeks, consisting of 5–6 days of estrus and about 15 days of diestrus. Ovulation tends to occur less than 48 hours before the end of estrus (Hughes et al. 1972b).

Considerable variation occurs in cycle length and character between mares as well as seasonally within a given mare (Figure 13.1 and Table 13.1). Some mares under management conditions exhibit estrus periodically throughout the year; yet, in some of these cases, ovulation is limited to the breeding season. Ginther (1979) concluded the reproductive season of pony mares is much more delineated into ovulatory and anovulatory seasons than in horse mares. During pregnancy some mares may show a bout of estrus, but this is not the norm; Asa et al. (1983) found no full estrus nor intromissions in any of the 12 pregnant mares they observed. Once parturition has occurred, a mare may ovulate in 4 to 18 days. The mare's sexual receptivity at this time is often called 'foal heat' and begins on the average 8 days postpartum (Matthews et al. 1967). Free-ranging mares are occasionally seen to mate within hours after foaling. Pituitary concentrations of luteinizing hormone are initially low following parturition but increase rapidly (in the first weeks) after foaling; this rapid change in LH allows the mare to exhibit estrus and ovulate earlier in the postpartum period than other farm animals (Harrison et al. 1990).

While in diestrus as well as anestrus, a mare is not receptive to the testing and sexual advances of a stallion. As the stallion approaches, her ears are laid back, she exhibits restlessness, and tail switching often occurs (Table 13.2). She avoids the stallion by moving away, or when contacted she suddenly squeals and threatens the male using bite threats as well as undirected striking and kicking. If the stallion persists with teasing, the mare no longer just threatens but directs her attack to the stallion's body.

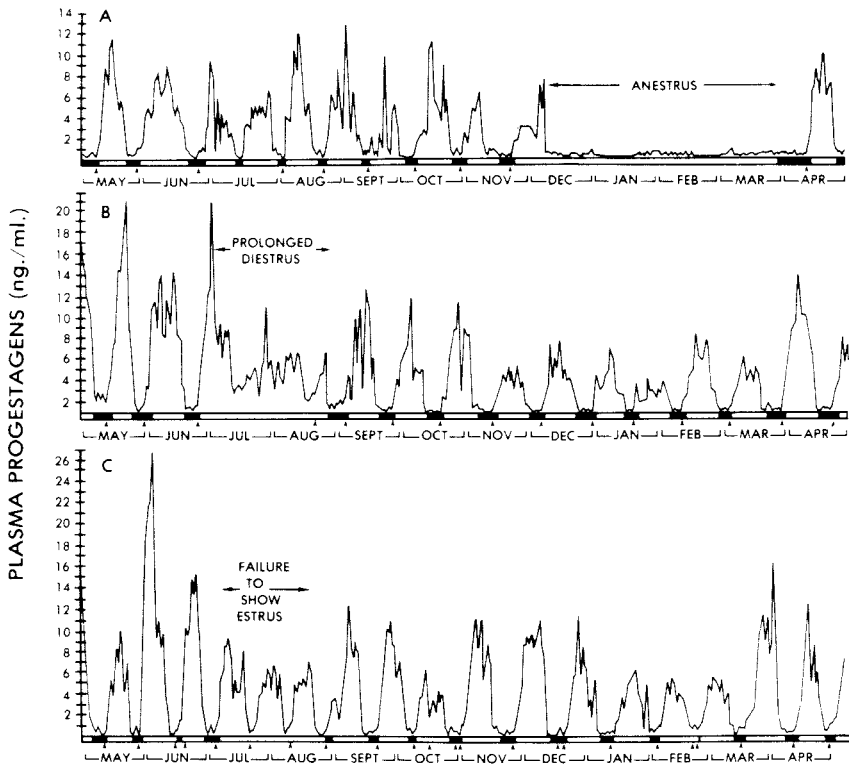


Figure 13.1: Variations in reproductive cycles of mares showing plasma progesterone levels, periods of estrus (dark bands), and ovulations (arrows): (a) typical annual pattern with anestrus, (b) periodic estrus throughout year with occasional prolonged diestrus, (c) cycles with irregular ovulations and periodic failure to show estrus. (Adapted from Hughes et al. 1972a; Rossdale and Ricketts 1974; Stabenfeldt et al. 1975)

When estrus occurs, a mare becomes relatively docile in the presence of a stallion. She allows the stallion to sniff, nuzzle, and nibble her. Occasionally a mare may squeal and paw the air, only to then turn her head and touch the stallion's muzzle. Oftentimes an estrous mare shows alertness and increased activity. Urination, generally in small quantities, is frequent; Asa et al. (1979) observed one mare urinate a maximum of 21 times in one hour while in the presence of a stallion. The urination posture with hindlegs spread with tail raised (and slanted to one side) tends to be prolonged after urination and is often repeated during estrus (Figure 13.2).

Table 13.1: Characteristics of Mares in Breeding and Non-Breeding Seasons of the Year*

Characteristic	Mean±SD	Range
Breeding Season		
Length (days)	152±50	78–288
No. of ovulations/mares		
Total	7.2±2.0	5–10
Associated with estrus	6.8±2.4	4–10
Quiet	0.4	0–1
Double	0.1	0–1
No. of split estrous periods/mare	0.9	0–2
No. of anovulatory estrous periods/mare	0.1	0–1
Length of estrus (days)	7.1±4.2	1–26
Length of diestrus (days)	16.3±2.9	11–25
Length of interovulatory interval (days)	23.3±3.1	17–33
Anestrous Season		
Length (days)	214±50	138–288
Unseasonable estrus		
No. of periods/mare	7.1±6.6	0–19
No. of days/period	2.3±2.5	1–14
No. of days/mare	16.6±17.4	0–43

*Sample of 14 mares ranging in age from 4 to 15 years.

Data from Ginther 1974

Upon assuming the urination posture, the mare may periodically squat by lowering the pelvis. Winking (the eversion of the vulva exposing the clitoris) occurs repeatedly during the presenting stance (Figure 13.3). Fraser (1970) summarized the courtship activities of horses into four pre-coital phases: (a) greeting with nasal contact, (b) active interchange of tactile and vocal responses between stallion and mare, (c) estrous display by the mare, and (d) her passiveness.

Associated with estrus in the mare are changes in the genital tract. For example, the vulva may become elongated, and the labia tend to swell slightly. As estrus proceeds, vaginal fluid increases and becomes less viscous. Vascularity of the lining tissues and cervix increase giving the membranes a red coloration. Furthermore, the cervix changes from being tightly closed to being relaxed and open at full estrus.

Plasma levels of the hormones estradiol, androstenedione, and luteinizing hormone peak during estrus at or shortly before ovulation (Table 13.3).

Table 13.2: Frequency of Behavior Patterns of Mares in Estrus and Non-Estrus While Individually Teased With a Stallion*

Behavior**	Percent Occurrence During Estrus***	Percent Occurrence During Non-Estrus
Raised tail	97.9	12.2
Urinated	53.9	7.0
Winked clitoris	87.1	10.2
Remained calm	89.0	7.4
Nuzzled stallion	12.9	5.1
Posturing	72.3	1.8
Kicked	10.8	54.5
Bit stallion	3.2	34.2
Held ears back	17.2	85.4
Switched tail	10.5	82.3
Moved about	20.1	93.4
Shook head	2.4	17.9
Pawed	2.9	27.6
Raised in front	0.9	7.8
Raised in rear	10.3	40.2
Vocal response	34.5	65.7
Snorted	0.9	7.8
Squealed	33.6	52.6
When mounted:		
Stood with tail up	100.0	1.6
Stood with tail down	—	7.2
Did not stand	—	42.6

*Based on 581 determinations during estrus and 2,181 during non-estrus using 20 mares.

**Teasing technique allowed mounting by stallion to occur.

***Estrus was defined as the mare standing firmly with tail up while being mounted, plus one or more of the following: (a) winking of the clitoris during teasing, (b) urinating during teasing, or (c) tail raising before being mounted or after being dismounted.

Data from Ginther 1979

Plasma progesterone levels fall rapidly before estrus and remain low until diestrus returns (Noden et al. 1975). The levels and interaction of at least some of these hormones are involved in estrus as well as in diestrus. Estrus can be accentuated with the administration of estradiol and suppressed by combining progesterone with estradiol or by using progesterone alone (Ginther 1979). When prolonged corpora lutea occur, estrus is inhibited but not follicular development or ovulation (Stabenfeldt et al. 1975).

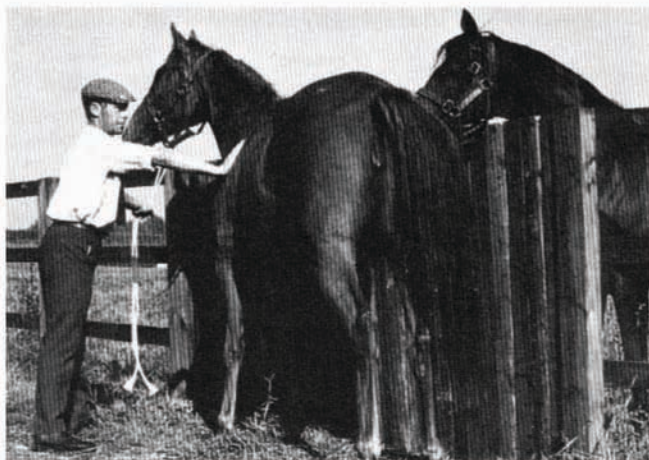


Figure 13.2: Mare exhibiting receptive stance and tail raising typical of estrous behavior. (Photo courtesy of P.D. Rossdale)



Figure 13.3: Eversion of the vulva and clitoris in an estrous mare constituting the behavior called winking. (Photo courtesy of P.D. Rossdale)

Table 13.3: Average Plasma Hormone Concentrations During the Estrous Cycle of Six Mares

Stage of Cycle	Progesterone (ng/ml)	LH (ng/ml)	Estradiol (pg/ml)	Estrone (pg/ml)	Androstene- dione (pg/ml)
Before estrus (5 days)	17.1±2.3	71±20	2.2±1.0	11.0±2.6	190±20
Before estrus (2 days)	5.3±2.0	102±11	5.6±0.6	9.2±0.9	180±30
Onset of estrus	0.7±0.2	323±78	7.1±1.6	9.7±0.8	180±30
Before ovulation (1 day)	0.4±0.1	661±113	11.5±2.5	12.5±2.3	380±70
Ovulation detected	0.8±0.5	918±199	6.8±1.7	11.2±1.7	220±30
Onset of diestrus	5.0±1.3	806±124	4.7±0.9	11.8±1.6	190±20
Mid-diestrus (7–9 days after ovulation)	13.6±2.2	123±35	4.3±0.7	10.0±1.1	210±40

± SE

After Noden et al. 1975

Since both ovariectomized mares as well as mares during the non-ovulatory season frequently exhibit estrus and copulate, and since experimental destruction of corpora lutea shortens diestrus, the accumulated evidence strongly suggests that progesterone may function, in part, to inhibit sexual behavior (Asa et al. 1980) and adrenal cortical androgens and/or estrogens may at times facilitate mare libido (Asa 1986).

Under open-range conditions mares commonly are members of a relatively stable female group tended by a single stallion. When the stallion does not court an estrous mare, she may eventually move to the stallion and even assume the solicitous stance near him. If initially ignored, she grazes nearby and resumes the estrous stance periodically. Copulation typically ensues. Young mares, when in estrus, may leave their social group when ignored by the harem stallion and seek other males. Sometimes they join a bachelor male in the vicinity. Although rare, mares in estrus occasionally mount or are mounted by other mares. When a range has only a few harem stallions, it is not unusual for an adult mare of a stallion-less group to depart temporarily from her companions during full estrus and seek contact with an adult male. Occasionally free-ranging harem bands are tended by more than one stallion; however, in multi-stallion bands sexual harassment can lead to poorer mare well-being and reproductive success (Linklater et al. 1999). Thus, a mutual long-term stable relationship between a mare and stallion has merits.

Not only do stallions show a preference for certain females, mares also can be choosy. To test this, Pickerel et al. (1993) monitored eight mares who were free to interact with stallions across a barrier. Mares were tested individually with stallion pairs; each mare received 30 trials. Six test stallions were paired in 30 combinations. For each trial, a mare was led to the two test stallions (each separated from the other in adjacent stalls) and given a 10-second visit with each test stallion across a teasing wall. Immediately thereafter the mare was returned to a position 5.3m in front of the two stallions and released inside the closed barn. Then her behavior was monitored for 125 seconds. Only when in estrus were mares inclined to show a preference and spend time within one body length of a stallion. Four mares had a single-stallion preference and the other four had a near-equal preference for two males; of the six stallions, two were not preferred by any of the mares but one seemed attractive to five different mares. A positive correlation was found between the preference ranking for a stallion (as determined by the mean time mares spent with the stallion) and the rate at which the stallion vocalized. All estrous displays (except for squatting) were exhibited in a higher percentage of trials in which their preferred stallion was present.

Most horse breeding operations routinely 'tease' mares using a stallion and look for positive and negative behavioral indicators of estrus. Records are commonly kept on each mare's cyclic patterns, since within-mare variability is relatively low; the most likely time for ovulation can then be estimated. Teasing is a well-accepted method of estrous detection, but not all horse owners have a stallion available for teasing. In an attempt to find a reliable, efficient, and economic method to determine estrus without using a stallion, Veeckman and Ödberg (1978) studied the possible application of acoustical and tactile stimuli. Acoustical stimulation consisted of stallion courting sounds played back for a period of 2 minutes 1–2m from the test mares. Tactile stimulation consisted of manual manipulation of the mare's neck crest, flank, or external genital region. A combination of acoustical stimulation with tactile stimulation of the flanks and external genitalia provided the best reactions. Signs of standing still, raising the tail, and spreading the hindlegs were readily elicited during estrus; during diestrus the indicators of kicking and squealing occurred. McCall (1991) reported that playback of stallion vocalizations as an aid to detect estrus was not useful for the 12 mares she studied.

The urine of a mare in estrus seems to contain odorous cues that facilitate the interest of the stallion. The urine discharge and genital region of

an estrus mare during teasing typically receive investigation by the stallion. A stallion that is then not sufficiently aroused to mount the mare may prolong the smelling of the genital region or the urine on the ground and subsequently exhibit a flehmen response. Flehmen per se does not indicate a high sexual interest. It is a means of chemically testing the mare's condition. Further arousal may or may not follow. For horses, no strong evidence exists that odors serve as distant sexual attractants. Observational data indicate the stallion, when not approached by an estrous mare, is initially attracted to her by visual cues, primarily the prolonged tail-raised urination-like stance with vulval winking.

A bout of mutual grooming or other means of developing the mare's trust may need to precede copulation in some instances. Inexperienced mares, such as young mares in their first estrus, display the estrous posture near stallions but then tend to exhibit a fear response when approached by an interested stallion. The timid mare may move away or show some degree of snapping response (see Chapters 3 and 19). Tyler (1972) observed that allogrooming seems to overcome the apprehension of such mares; copulation successfully follows. Woods and Houpt (1986) reported an approach-avoidance conflict situation where an older mare exhibited a facial gesture characteristic of snapping only when in estrus and was approached by a stallion. Whenever the mare was not in estrus, there was no conflict; she boldly rejected the stallion and showed no snapping.

During copulation the receptive mare generally retains a stationary position, with legs spread to maintain her balance. Her ears are usually up, the eyes remain attentive, and the mouth is closed or opened slightly. The mare's neck maintains a moderate level, neither drooped as is characteristic of some equids nor elevated. Commonly mares turn their head slightly to observe the stallion; Asa et al. (1979) found such looking frequently occurred during ejaculation.

After the stallion dismounts, the mare often is the first to move away [e.g., in 60 percent of the matings Tyler (1972) observed]. Usually the mare moves only a few meters and may soon return to the proximity of the stallion and continue to show tail raising and frequent urination. The stallion, however, does not show further sexual interest in the mare for many minutes. He may investigate the ground and spilled ejaculate. Under field conditions, other behaviors and events usually then intervene, thus the mare and stallion soon move apart. Grazing commonly ensues.

■ Intensity and Duration of Estrus ■

The intensity of estrus varies between mares and oftentimes within-mare variation is apparent. A mare's receptivity may peak and wane more than once during estrus or remain relatively constant. Each individual mare tends to show her own characteristics, which are often similar from one cycle to another. A daily rhythm of sexual receptivity is not apparent; copulations occur at any hour and usually several times during estrus. Mares are, however, especially solicitous and receptive 1–3 days before the ovum is released from the ovary. Ovulations may occur primarily at night (Studiencow 1953; Witherspoon and Talbot 1970); yet, the data are not conclusive (cf. Ginther et al. 1972). Although mature follicles can rupture at any time in the cycle, ovulation is typically associated with the end of an estrous period, 12 to 72 hours (mean = 36 hr) before the end of estrus (Ginther et al. 1972). Sexual receptivity usually decreases after ovulation until estrus ceases. Wallach (1978) found evidence that sexual receptivity may begin to decrease even before ovulation.

The duration of estrus is not rigid but is commonly within a range of 5 to 15 days. Nevertheless, extremes of 1 to 50 days have been reported (Rossdale and Ricketts 1974). Trum (1950) and Ginther et al. (1972) found the length of estrus decreases as the breeding season progresses into summer, whereas diestrus increases in length. Toward the end of the breeding season the trend reverses; the curvilinear relationship is shown in Figure 13.4. Thus in mid-summer, estrus is relatively brief especially compared to early in the season. The length of diestrus changes correspondingly so that the length of each estrous cycle and the interovulatory interval vary little throughout the breeding season.

Veterinary procedures, such as rectal palpation, may influence the duration of estrus. Voss and Pickett (1975), for example, found estrus lasted longer in non-palpated mares than in the mares palpated. The stress of transport seems not to alter estrous behavior, ovulation, or the duration of estrus (Baucus et al. 1990b).

In some mares, estrus is manifested but then ceases for a day or so before sexual receptivity again returns. Since the mare appears to be in one estrous period, such a phenomenon is called split estrus. The frequency of split estrus varies. For example in one study, Ginther et al. (1972) found split estrus occurred in 4.9 percent of the estrous periods, whereas with other mares (Ginther 1974) the occurrence was 12 percent.

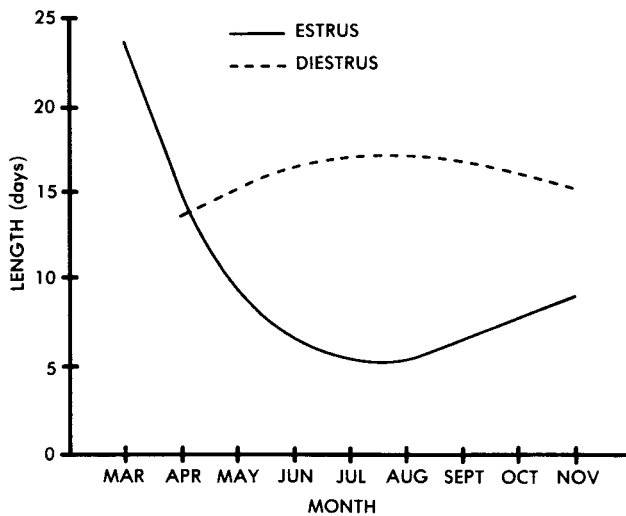


Figure 13.4: The effect of season on the length of estrus and diestrus in the northern hemisphere. (After Ginther 1974)

Prolonged estrus can also occur lasting several weeks. Such lengthy estrous periods occur more often at the start of the breeding season. Poor nutrition or other physiological disruptions are usually considered the cause.

Mares can ovulate without showing estrus. It seems typical of some mares. They ovulate at regular intervals but fail to show clear evidence of sexual receptivity. The incidence of such covert or silent estrus is about 7 percent. The causes of diminished estrous behavior in mares are not known; yet, concentrations of circulatory hormones may be involved. The morphological development of follicles does not seem to be a factor (Ginther 1979).

Control of the Estrous Cycle

As with other farm animals, researchers have sought ways to influence the estrous cycles of mares. Two goals are especially sought: (i) to regulate estrus and ovulation so as to increase conception and reduce the number of matings required plus (ii) to facilitate breeding outside of the normal breeding season. The first reason is to increase breeding efficiency; the second, is to adjust equine reproduction to the whims of mankind. In some horse breed associations, foals become one year of age on January 1 regardless of the actual birth date. Thus, to have horses that can successfully compete

at the track or in the show arena as yearlings or as 2- and 3-year-olds, breeders attempt to have conception occur in February or early March—at a time when normal ovarian activity and ovulation may not yet be re-established.

In any attempt to control the estrous cycle, it is important to realize that inducing estrus does not assure reproductive benefit since sexual receptivity without ovulation can occur (e.g., some ovariectomized mares show estrus). Likewise, inducing ovulation without achieving estrus is also unproductive. Ova are oftentimes shed from the ovaries of mares outside of estrus and probably are seldom fertilized. Ovulatory estrus is the goal of manipulations—so conception will result.

Intrauterine Saline Infusion

Infusing the uterus with a saline solution is a technique that has been used to induce estrus in mares. Only mares beyond the fourth day of diestrus will respond and come into ovulatory estrus. Infusions administered between 5 and 9 days after the start of diestrus hasten the onset of estrus and reduce the interovulatory interval (Arthur 1970; 1975; Ginther and Meckley 1972). Non-cyclic mares in prolonged diestrus have responded by showing ovulatory estrus 3 to 9 days after infusion; nevertheless, infusions have not been effective in shortening seasonal anestrus (Arthur 1975).

Uterine infusion in the diestrous mare induces premature regression of corpora lutea 4 to 5 days old or older (Neely et al. 1975). Thus plasma progesterone levels normally drop considerably following such treatment.

Photoperiod Manipulation

The use of artificial lighting to induce estrus during the winter non-cyclic period has met with success. The ratio of the light-dark photoperiod is adjusted (continuous light may delay onset of the mare's cyclicity). Once a photoperiod of 16 hours light and 8 hours dark is achieved, it is maintained (Watson 1998). Beginning two or more months prior to the normal breeding season, the lighted portion of a mare's photoperiod is increased in a stepwise manner or as a single major increase using 200 to 400 watt bulbs (Burkhardt 1947; Nishikawa 1959; Loy 1967). Under such treatment, mares tend to show an early onset of the breeding season. Sharp et al. (1975) exposed seven pony mares to an increasing light and temperature regimen during the winter months and found estrus became evident in all seven mares; ovulation occurred in two. Seven control mares on the same diet and housing conditions, but kept under the winter photoperiod and temperatures, did not exhibit estrus or ovulation. Sharp and Seamans (1980) suspected an

evening photosensitive phase which may be important in regulating a mares seasonal activity. Subsequently, Sharp (1986) reported success lengthening the photoperiod 2.5 hours after sunset but found lengthening the lighted portion 2.5 hours before sunrise was totally ineffective.

Hormone Injection

A variety of hormones and similar chemicals have been used to manipulate the estrous cycle of mares (see Gordon 1997). Experimentation will undoubtedly continue to be active as new compounds are identified and available.

Human chorionic gonadotropin (HCG), chemically similar to luteinizing hormone, has for decades been used to induce ovulation in mares. It is effective provided there is a follicle sufficiently mature (>2.5 cm) to ovulate, otherwise luteinization of an immature follicle may result (Rossdale and Ricketts 1974). HCG administration early in estrus will not only induce ovulation in approximately two days, it will also shorten estrus (Loy and Hughes 1966). Intravenous injection of synthetic gonadotropin releasing hormone (GnRH) also advances ovulation and shortens estrus (Irvine et al. 1975). Injections of pregnant mare serum gonadotropin (PMSG) appear to not reliably influence equine ovarian activity (Rossdale and Ricketts 1974).

Estrus can be induced by estrogen injection (e.g., diethylstilbestrol); yet the effectiveness of estrogen administration alone is variable. If a mature follicle is present, an estrogen injection can induce ovulation before behavioral estrus occurs (Rossdale and Ricketts 1974). Azzie (1975) found subcutaneous implants of estradiol benzoate (deposited during the normal anestrus period of mares) induced estrus within 2 to 4 days; nevertheless, the mares returned to anestrus after two weeks and developed masculine characteristics until implants were removed. Their masculinization included prevalent fighting and teasing behavior when with other mares. Schumacher et al. (1987) also noted behavioral masculinization resulted from anabolic steroid injections.

Estrus and ovulation can be blocked in mares using intraperitoneal injections of an antiserum containing antibodies against both follicle stimulating hormone and luteinizing hormone when treatment occurs during estrus (Pineda and Ginther 1972). Estrus and ovulation can also be blocked by intramuscular injection of progesterone administered in daily doses of 100 mg or higher if begun mid-cycle during the luteal phase (Loy and Swan 1966). Doses of 50 mg per day were found to prevent estrus but not ovulation. Daily administration of exogenous progestogens, Loy and Swan

found, can neither stop estrus nor block ovulation if treatment is begun on the first day of estrus. Progesterone administration on days 5 through 16 during a 23-day sequence of GnRH treatment brought acyclic mares into ovulatory estrus 24–38 days after treatment began in late winter anestrus, Hughes (1978) reported. Progesterone injections on a daily basis after parturition can be used to delay postpartum estrus and ovulation (Loy et al. 1975). Harrison et al. (1990) found that as the interval following parturition increases, the amount of LH (but not FSH) secreted from the pituitary increases under GnRH treatment.

Estrus that occurs in some ovariectomized mares cannot be attributed to hormones of ovarian origin. The source of influential steroids in such cases is likely the adrenal cortex. In a study supporting this, Asa (1980) administered to ovariectomized mares a synthetic corticosteroid called dexamethasone which suppresses the synthesis of steroids in the adrenal cortex. Some experimental animals were given dexamethasone plus estradiol in case the effect of dexamethasone was other than on the adrenal gland. The incidence of estrus and thus copulatory behavior was significantly reduced in mares treated only with dexamethasone.

Prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) given subcutaneously induces resorption of corpora lutea in otherwise normal mares injected on day 6 of diestrus, and mares return to ovulatory estrus 3–4 days after treatment (Douglas and Ginther 1972). Hurtgen and Whitmore (1979) concluded that endometrial biopsy had similar effects on mares because of stimulating the release of prostaglandin. Allen and Rosedale (1973) administered a synthetic prostaglandin analogue intramuscularly and by infusion into the body of the uterus and similarly caused regression of corpora lutea more than 4 days old as well as induced estrus within 4 days. Oxender et al. (1975) found that mares treated by uterine infusion with $PGF_{2\alpha}$ returned to estrus an average of 2.2 days after treatment and stayed in estrus an average of 7.5 days (more than 2 days longer than control cycles). Thus prostaglandin administration terminates the luteal phase of the estrous cycle and returns the mare to ovulatory estrus.

Other Manipulations

Additional influences over the equine estrous cycle have been reported but not extensively investigated. Genital stimulation has been reported by Prahov (1959) to aid in inducing estrus in non-cyclic mares. In a study of the effects of rectal palpation on the reproductive characteristics of mares, Voss and Pickett (1975) noticed estrus lasted significantly ($P < 0.05$) longer in

non-palpated mares than in palpated mares. Furthermore, they found a higher percentage of non-palpated mares conceived earlier in the breeding season compared to palpated mares.

Nutrition and feeding patterns also influence the sexual behavior and ovarian activity of the mare. Belonje and Van Niekerk (1975) reported a study where seven mares were provided supplementary feed in the latter part of winter and another group had only natural pasture. In the supplemented group, all mares gained weight, showed estrus, and ovulated within 43 days; whereas among the eight non-supplemented mares, two lost weight and did not show estrus, four showed estrus but did not ovulate, and two mares gained weight and had an ovulatory estrus. Mintscheff and Prachoff (1960) found that a feeding program of one day of no food followed by a controlled level of feeding on subsequent days caused a reduction in the duration of estrus.

Abnormal Sexual Behavior of Mares

From spring through autumn, mares typically exhibit estrus for a few days every three weeks; thus noticeable variations from this pattern are considered atypical or abnormal. Split estrus and prolonged estrus are examples commonly seen. In the peak of the breeding season, prolonged estrus is rare. During the spring and summer, some mares will fail to show clear signs of estrus yet may otherwise be cycling. Others may urinate frequently, posture in an estrous manner, present to males, yet object to being mounted. The underlying cause of atypical traits may include an endocrine imbalance (e.g., from a tumor or persistent follicles), malnutrition, traumatic experience, or other factors. Mares with physiological disruptions, including nutritional abnormalities, may not cycle normally; therefore, their sexual behavior will be altered. Some mares with congenital problems, such as abnormal number of sex chromosomes, have infantile reproductive organs and suppressed or irregular estrus.

Occasionally a mare may show stallion-like behavior (Figure 13.5). The individual may approach another mare with arched neck, vocalize, and further tease the other mare (Stabenfeldt and Hughes 1977). Mounting by estrous mares as well as by non-estrous mares toward mares in heat can also occur (Rossdale and Ricketts 1974; Fretz, 1977; Asa et al. 1979). Unlike cattle, such events are atypical in horses. Azzie (1975) reported stallion-like tendencies in mares with a subcutaneous implant of estradiol once the initial estrus subsided and the mares resumed anestrus.

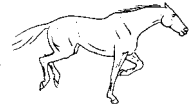


Figure 13.5: Grey mare three-months pregnant exhibiting unusual possessiveness, teasing, and mounting behavior toward a mare in estrus.
(Photos courtesy of P.D. Rossdale)

Cougouille-Gauffreteau (1984) reported that mares injected with androgens subsequently rose in the herd dominance hierarchy and exhibited some degree of stallion-like behavior, ranging from herding and scent marking to testing the estrous status of mares and mounting those in estrus. Squires et al. (1985) found stallion-like behavior in 3-year-old mares periodically injected for a year with anabolic steroids; the abnormal behavior decreased after treatment but was observed subsequently in some mares for up to 6 months. Compared to controls, fewer mares exhibited estrus in the breeding season following treatment and those that did had a shorter period of estrus. Other effects occurred, thus the investigators concluded steroids should not be used in mares intended for reproduction.

Stallion-like behavior was associated with a masculinizing ovarian tumor (arrhenoblastoma), elevated serum testosterone, and low serum estradiol in the case reported by Fretz (1977). After the neoplastic right ovary was surgically removed, the mare's behavior returned to normal. Such tumors may not explain all cases; for example, the pregnant mare who displayed the mounting behavior shown in Figure 13.5 foaled normally and was subsequently normal (Rossdale and Ricketts 1974). In the case of the mare-mare mounting observed by Asa et al. (1979), the estrous mare who exhibited mounting was repeatedly ignored by the stallion who tended and mounted another mare in the enclosure. Asa and her co-workers concluded the mare's atypical response was perhaps a form of redirected behavior under the highly sexual situation.

14 Maternal Behavior



Parental care of foals is primarily given by the mother. Only occasionally is apparent protection of a foal exhibited by the sire (e.g., harem stallion), by a sibling, or by a mare other than the mother. Stallions in feral herds have been seen on a few occasions to retrieve foals separated from the maternal band, and other individuals (e.g., mares without foals) sometimes show a tendency to shelter and protect youngsters (e.g., see Feist and McCullough 1975). In most cases, a mare keeps her newborn at her side and greatly limits the direct contact her foal has with other horses. Soon after parturition, during a sensitive period lasting an hour or two, the mother imprints on her neonate and thereafter exclusively provides it with its nutritional and protective needs.

■ Pre-Parturient Behavior

The length of pregnancy in horses is approximately eleven months. In a study of 498 Thoroughbred mares in England, Rosedale (1967a) found the average gestation based on last service by the stallion was 340.7 days with a range of 327 to 357 days for 95 percent of the mares. In South Australia, Ropiha et al. (1969) determined the duration of pregnancy for 522 Thoroughbred mares based on ovulation to parturition ranged from 315 to 387 days; ten foals were carried for more than 12 months. The average gestation in their study was 342.3 days. Hendrikse (1972) found slightly shorter durations in smaller breeds of horses than in larger breeds; in total, the average gestation for horses in the Netherlands was found to be 340 days.

Environmental factors, such as season and nutrition, interacting with such factors as the sex of the foal and individual variation of the mare can affect the duration of pregnancy. For example, well-fed mares appear to foal

slightly earlier than mares on a maintenance diet (Howell and Rollins 1951). Pregnancy is longer for foals conceived in early spring compared to conceptions resulting from late spring or early summer matings (e.g., see Hintz et al. 1979). Nutritional effects alone are not responsible for this trend. Interesting also is the observation that fillies are born a day or two earlier than male foals (Ropiha et al. 1969). The age of the mare appears to have little effect on the duration of pregnancy, but Campitelli et al. (1982) found the heaviest foals were born to mares 6–11 years of age. Although foaling can occur throughout the year, among free-ranging horses, most births occur from mid to late spring (Feist 1971; Tyler 1972; Welsh 1975; Keiper 1975; Green and Green 1977; Salter 1978; Boyd 1980; Berger 1986).

Throughout most of the period of pregnancy, the mare's behavior is not greatly altered until shortly before parturition. Since hormonal levels change and other physiological alterations occur during pregnancy, subtle behavioral changes may well be happening that have not been documented.

Growth of the two mammary glands begins about a month prior to parturition, and milk secretion may appear several days before foaling. As parturition nears, waxy material usually appears at the distal end of the milk canal on the now enlarged teats. Relaxation of the pelvic ligaments cause a surface depression on either side of the sacrum, and lengthening as well as swelling of the vulval lips occur one to two days before the foal is born (Rossdale 1967a).

Within one to four hours before parturition, the mare begins to show evidence of increased discomfort and restlessness. Sweating may be evident at the flanks and girth. A sheltered, out-of-view site may be sought. If conditions permit, mares sometimes seek isolation by leaving their social group or by letting the group move away. Blakeslee (1974) reported the separation in free-ranging Appaloosa horses may be as much as 5 km and suggested that the more dominant mares may separate the farthest. Tyler (1972) noticed varying degrees of isolation occurred in the New Forest ponies. Some mares were well isolated, others foaled while yearlings or other horses were nearby, and still others gave birth close to busy roads with concomitant spectators. Collery (1978) concluded that young mares, especially those foaling for the first time, were the mares that showed the least tendency to withdraw from the social group. Boyd (1980) found no evidence that mares sought isolation under the feral conditions of the Red Desert of Wyoming.

Mares maintain considerable control over the time of foaling by being able to prolong the initial stage of parturition if disturbed (Koch 1951). Thus my

efforts and those of others to film and be on hand during parturition have been considerably frustrated because of the reaction of mares to bright lights and human observers. Mares tend to give birth during darkness or in the early morning hours when light levels are low and disturbances are greatly reduced (Rossdale and Mahaffey 1958; Flade 1958; Zwolinski 1966; Rossdale and Short 1967; Tyler 1972; Campitelli et al. 1982; Berger 1986).

Parturient Behavior

Having achieved some degree of isolation, a mare signals impending parturition by her restlessness, patchy sweating, and overall uneasiness. Circling, pawing, and occasional displacement eating may occur. Additional signs of discomfort appear with repeated recumbency and standing, looking at the flanks, tail raising, and restricted rolling (Wright 1943; Rossdale and Mahaffey 1958; Walser 1965; Rossdale 1967a). This initial stage of labor may last only minutes or occur for hours.

Rupture of the chorio-allanotic membrane and the escape of the allantoic fluid commences the second stage of labor. It usually occurs while the mare is standing, preceded by dorsoventral tail motions slapping the perineum and a crouching urination posture. Before becoming recumbent, the mare usually discharges noisily some of the allantoic fluid. Some mares investigate the allantoic fluid discharge and may then exhibit flehmen. A tendency to lick the fluid, their skin, and nearby objects is common, and sometimes a nicker is emitted as labor continues (Rossdale and Ricketts 1974).

Recumbency soon occurs and strong contractions become evident. A large quantity of allantoic fluid is often discharged as the mare's hindquarters first contact the ground. Sternal recumbency is maintained with early expulsion efforts. Bouts of strong uterine contractions force the forelegs of the foal into the vagina with its muzzle inserted between or adjacent to the legs. Oftentimes mares stand and change positions as the foal's forelegs and muzzle protrude from the vulva covered by the amniotic membrane. Some mares get up and down repeatedly, especially if disturbed (Rossdale and Mahaffey 1958).

Final delivery of the foal is nearly always completed while the mare is in lateral recumbency with legs extended (Figure 14.1), rarely while standing. Numerous expulsion efforts occur. In a sample of five mares, Rossdale and Mahaffey (1958) counted 60 to 100 straining efforts occurred between the first appearance of the amnion until delivery was completed.



Figure 14.1: The appearance of the forelimbs and head of the foal during parturition. (Photo courtesy of P.D. Rossdale)

Mares often elevate their extended upper hindlimb during expulsion efforts. Incomplete rolling movements sometimes occur. Much of the time is spent with delivery of the head and forequarters then proceeds rapidly until the foal's hips are delivered and only the hindlegs remain in the vagina. At this point expulsion efforts cease (Rossdale and Mahaffey 1958) and the foal is considered born.

The interval from the rupture of the chorio-allantoic membrane to the delivery of the foal's hips varies from one occasion to another. Rossdale (1967a) found it averaged 18 minutes (range 5–47) for mares experienced in foaling and 21 minutes (range 5–43) for first-foaling mares. For 24 pony mares, Jeffcott (1972) found the second stage of labor averaged 12 minutes (range 4–25).

Parturition occurs with the foal usually encased in the amniotic membrane. Movements of the foal lead promptly to the rupture of the amnion and breathing commences. Normally this occurs when the foal raises its head away from the forelegs during delivery. The forequarters become exposed as the foal slides from the membrane (Figure 14.2).

In the first moments after birth, the mare and foal are relatively inactive; the mare remains in lateral recumbency, and the foal assumes sternal recumbency. Unless disturbed, the mare typically remains recumbent for many minutes. As the foal begins movements to drag its hindlegs free of the vagina and membranes, the mare often assumes sternal recumbency and turns her head toward her foal. Nuzzling of the foal and quiet nicker vocalizations sometimes occur.



Figure 14.2: When the mare's contractions cease, the foal's hindlegs remain in the mare and the umbilical cord remains intact.
(Photo courtesy of P.D. Rossdale)

The umbilical cord commonly does not sever until the foal moves itself away from the mother or until the mare attempts to stand (Figure 14.3). Rossdale and Mahaffey (1958) observed that the delay of several minutes before the umbilical cord breaks allowed time for the physiologically-beneficial transfer of 1000–1500 ml of placental-fetal blood to reach the foal. Severance of the cord too soon therefore results in depriving the foal of considerable blood otherwise left in the tissues of the afterbirth. Since mares normally remain recumbent, the foal's creeping movements away from the mother usually cause sufficient stretch to break the cord about 3 cm from the foal's abdomen. Thus several minutes after the dam's contractions cease, the foal commonly pulls its hindlegs free of the mother as well as the membranes and accomplishes severance of the umbilical cord.

Post-Parturient Behavior

While the foal struggles to achieve standing, the mare usually stands and soon begins a prolonged period of licking her newborn. Continuous licking may last 30 minutes. The vigorous licking proceeds over the foal's body and once complete rarely occurs again with such persistence. It is during this early contact that the mother commences her strong social attachment to her foal.

In human-attended barn situations, Rossdale (1967a) found 83 percent of the mares observed ($n = 257$) stood within 16 minutes after foaling; some mares remained recumbent for up to 40 minutes. The presence of attendants may have induced some early standing; nevertheless, only 23 percent of the mares stood prior to 4 minutes after delivery.

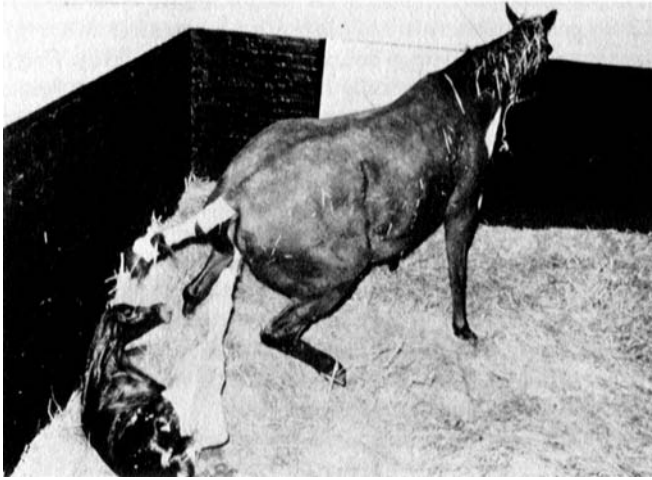


Figure 14.3: Foals often free themselves from the fetal membranes, but here the mare stands soon after parturition, pulling the membranes and breaking the umbilical cord. (Photo courtesy of P.D. Rossdale)

Mares become protective of their foal during the early neonatal period. As intruders approach, sheltering and herding of the foal are exhibited. If the foal is lethargic, the mare often becomes impatient and may strike the foal gently with her forefoot. Stillborn foals are eventually pawed forcefully by mares (Rossdale and Mahaffey 1958). Once, while we fondled a recumbent newborn foal in our experiments with human socialization, the restless mare gave the foal a swift strike with one foreleg as if to induce the foal to stand and withdraw with her.

When not attending the foal, a mare may nibble at hay or straw, sniff and lick objects smeared with birth fluids, and become occupied with discharging the placenta. Expulsion of the afterbirth concludes the third stage of labor. Campitelli et al. (1982) noted the expulsion process commences, on average, 43 minutes following parturition; Rossdale and Ricketts (1974) found expulsion was completed a mean of 60 minutes after parturition. By the end of the second hour, most mares (86 percent in Rossdale's 1967a study) have discharged the placenta; yet retention can last for hours. Tyler (1972) observed one free-ranging pony with a retained placenta 8 hours after delivery. Inconsequential retentions lasting up to 24 hours have been reported by Wright (1943).

Expulsion of the placenta normally is preceded by repeated sessions of recumbency with rolling and restless evidence of discomfort. The mare may

sweat, look at her flanks, paw the ground, and groan. Meanwhile the foal has been able to achieve a standing posture. During the bouts of recumbency and rolling by the mare, the foal commonly exhibits excitement and circles or paws the mother. Maternal care is noticeably reduced during the peak period when the mare struggles with discomfort prior to placental expulsion. Final discharge of the placenta often occurs during recumbency or just as the mare stands.

After the placenta and membranes have been discharged the mare begins to calm. She usually sniffs and may even poke the material with her upper lip; a flehmen response often follows. A mare does not normally consume the placenta and only rarely has been seen to nibble or ingest the afterbirth (cf. Virga and Houpt 2001). The horse is not adapted to hide foaling evidence; rather, under wild conditions, a mare and foal soon depart from the foaling site.

Once the foal stands, some mares position themselves to assist the foal in locating the teats. Nursing soon succeeds in such instances. However, other mares show avoidance instead and seem to resent their foal's activity near udders that are obviously quite sensitive. These mares may pivot and move away from the searching foal. In extreme cases, the foal may be bitten or kicked. If the foal places its head under the flank, the mare may squeal and bump the head of the foal with the stifle region of the hindleg during a hindleg lift. Avoidance may continue for hours; nevertheless, with time and continued care-seeking by the foal, initially obstinate mares begin to allow nursing. Once nursing is established, mares occasionally exhibit mild forms of aggression (e.g., a bump, nip, bite threat, or smack) toward foals to prevent or to discontinue nursing or they simply walk away.

A mare normally only allows her own foal to suckle. Smell, visual cues, and even auditory and gustatory cues seem to be utilized by a mare in recognizing her own offspring. The mare's recognition and attachment seem to initially develop during the licking and close contact of the first hour postpartum. Cox (1970) noticed that after months of separation only the mother and not other mares reacted with interest to a foal isolated from her several hours after parturition and subsequently hand reared.

Fostering a foal to another mare is usually difficult. One technique commonly utilized is to pair a foal recently orphaned to a mare that has lost her own foal (Tyler 1972; Rossdale and Ricketts 1974). The mare is induced to accept the strange foal by initially draping the foal with the hide of the mare's dead foal or with the amnion that covered her foal. The mare is allowed to smell as well as follow the disguised foal; nursing is encouraged by handlers.

Successful acceptance of the foal by the foster mother will most likely occur in 1 to 12 hours. When the hide or amnion are not available to accomplish fostering, the strange foal's odor can be masked with an odoriferous ointment placed on the foal or on the mare's nostrils (Rossdale and Ricketts 1974).

Within a few hours, a mare leads her newborn away from the foaling site and together they rejoin social companions. Yet mares with new foals are inclined to be somewhat socially disengaged and may maintain more distance from herd companions (Estep et al. 1993). Blakeslee (1974) concluded that subordinate mares rejoined their band sooner with their newborn foal than dominant mares. The mares were observed to move in bouts, stopping periodically. Sometimes herd members came to investigate.

A mare seldom willingly allows her newborn foal to have direct contact with other horses or humans. She calls the foal to her side with quiet nickers or intervenes with her body and herds the foal away. Previous young and strange foals are normally rejected using bite threats or kick feigning. When an intruder persists, the mare is apt to kick. Occasionally other horses attempt to adopt the newborn, especially mares that are soon to give birth. Blakeslee (1974) found geldings also showed the tendency to adopt foals. Boyd (1980) saw one instance where a deserted foal was adopted by a stallion and his band of five mares.

By withdrawal with her newborn sheltered at her side, a mare avoids most direct confrontations, such as with dominant individuals of the social group. If the foal is recumbent, the mare first rouses it with a quiet nicker or a nudge with her nose, causing it to stand and allowing timely withdrawal together. Although a subgroup in itself, the mare and newborn foal under free-ranging conditions are commonly a part of a larger social unit. The mare's close protectiveness and constant togetherness with her newborn is maintained for many days after parturition and is only gradually reduced.

A mare is most inclined to allow previous offspring, the more intimate mare companions (e.g., allogrooming partner), and trusted human handlers to first contact her foal. Protection and defensiveness may continue to be shown when other individuals approach. By four weeks of age, social interactions with other than the mother become more numerous, and foals increasingly interact in play and mutual grooming with peers (Tyler 1972).

The mother and foal both participate in maintaining periodic contact with each other. They separate only minimally. Tyler (1972) found, for example,

that during the first week foals were within 5m of the mare 94 percent of the time. At five months, mother-young pairs still spent 25 percent of the time within 5m and less than 10 percent at distances greater than about 45m. Beginning with the eighth month, the common distance of separation was between 5 and 25m. Boyd (1980) observed similar tendencies in the feral horses she observed.

Nursing of the foal decreases from a rate of about four bouts per hour in the first week to approximately once every two hours when the foal is eight months old. Natural weaning occurs at about one year of age, shortly before the mare gives birth to a new foal (Tyler 1972). Some mares wean their foals earlier, and if the mare does not have a new offspring, nursing of the previous foal often continues. Only rarely do mares allow more than the most recent offspring to nurse. In his study of feral horses, Berger (1986) found no relationship between weaning age and foal sex, maternal condition, or band stability; only the prior reproductive status of mothers was found to influence weaning age. For example, females without foals the previous year weaned their offspring at an average age of 16 months, whereas mothers with yearlings weaned their current foals at an average of 8.5 months.

Mares appear to initiate some bouts of nursing by approaching their foals and standing nearby. Once nursing is underway, some mares flex their hind leg on the side opposite the foal, as if to conserve energy (Crowell-Davis 1985). Boyd (1980) noticed mares with foals less than one week of age usually shifted weight on the hindlegs in a rocking motion before terminating a nursing bout. This pattern seemed to induce the foal to withdraw its head before the mare moved away. Mares terminate nursing primarily by moving away, especially during the foal's first month of age (Crowell-Davis 1985; Barber and Crowell-Davis 1994). Mares can prevent nursing by walking away, bumping the foal's head with a forward lift of the hindleg, or by aggressive biting or kicking. At weaning, the mare may repeatedly drive the foal away as it approaches.

After weaning, the mare and her offspring maintain some degree of companionship that may last into adulthood or only until the offspring becomes sexually mature or departs from the original group (Tyler 1972). In some cases, youngsters depart at a year of age. Others do so later (cf. Berger 1986). Under altered circumstances, some offspring remain in the maternal group as adults; oftentimes they can be seen to enter into a mutual grooming relationship with their mother.

Abnormal Maternal Behavior

A mare typically bonds to her newborn foal and successfully provides its nutritional needs and protection; a mare who has previously raised a foal usually proceeds with maternal care more easily than a primiparous mare. Delays and temporary disruptions to maternal behavior can occur because of physiological trauma, retained placenta, or other factors; yet normal traits commonly appear once the mare recovers. More rarely, maternal behavior may appear aberrant. Among the abnormalities of maternal behavior in horses include the lack of bonding to the neonate, refusal to nurse the foal, excessive aggression toward the neonate or others, and the mothering of another mare's foal (Houpt and Wolski 1979).

For a mare to readily bond to her foal, she needs ample quiet time to lick and nuzzle the foal in the first hour or so following parturition. Human disturbance and other factors can interfere. If the mother rejects the foal, it may be necessary to physically restrain the mare in a standing posture, so that she cannot turn or move forward or back yet allowing the foal access to the udder. This restraint may be necessary for a week or more. Subsequent to a series of successful nursing sessions, such mares tend to become more accepting of the foal, especially when nursing brings comfort to the mare and not pain. Besides restraint, some mares who appear to reject the foal may become more accepting of their neonate if temporarily separated from it or if the foal is threatened (e.g., bringing a dog into the vicinity) to stimulate the protective tendencies of the mare (Crowell-Davis and Houpt 1986).

It is not unusual for a mare to show limited aggression toward other horses, people, or other intruders when attempting to protect her foal. The amount of aggression is usually moderated to accomplish intruder withdrawal. Forcefulness may be exhibited toward the foal when the mare attempts to speed the foal's withdrawal from danger. Foals that are not their own are normally rejected by mares, especially when such youngsters attempt to nurse. Yet sometimes mares are seen to attack their own foal (cf. Houpt and Feldman 1993). Such excessive aggression may be the result of environmental factors (such as, human disturbance soon after parturition), the lack of a mare-foal bond or foal recognition, physiological disruptions (e.g., retained placenta), or other factors overwhelming a mare.

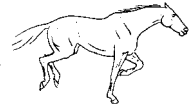
Occasionally horses attempt to mother foals that are not their own. This especially occurs in mares that are either close to parturition, are separated from their own neonate, or whose foal has recently died (Crowell-Davis and Houpt 1986). Orphaned foals can most easily be fostered to receptive, lactating mares who no longer have their own foal.

Part V



Social Behavior

15 Social Organization



When animals cluster into units for group defense and other benefits, they tend to do so with a degree of order that minimizes conflicts between individuals and permits the group to function effectively on a day to day basis. Thus, social organization involves group size and composition, membership and group stability, and such facets as the responsibilities and privileges of the individuals. There are organizational strategies typical of the species as a whole; yet, the patterns displayed within a given population are often shaped and fine tuned by the specific environmental context.

Herd Structure

Although some horses roam as solitary individuals, most horses prefer to remain with companions. Discrete social groups are called bands. A herd is a localized population consisting normally of one or more bands as well as solitary individuals. Interband dominance indicates that even at the level of the herd some social structure exists (Miller and Denniston 1979; Berger 1986). Bands of over 20 animals occasionally occur. More often, however, the band size of free-roaming horses is less than 10, with four being common (Figure 15.1). In the arid Pryor Mountain Wild Horse Range of Wyoming-Montana, Feist (1971) found 44 harem (family) bands had an average size of 5.0 (range 2–21). Welsh (1975) observed up to 50 bands on Sable Island and found the average band size was 5.5 (range 2–20). By comparison, the feral horses Salter (1978) studied in western Alberta had an average band size of 7.7 ($n = 18$, range 3–16). And on the llanos of Venezuela where many young stallions are removed for work, monthly band size averaged between 15.5 and 20.8 (range 3–35) (Pacheco and Herrera 1997).

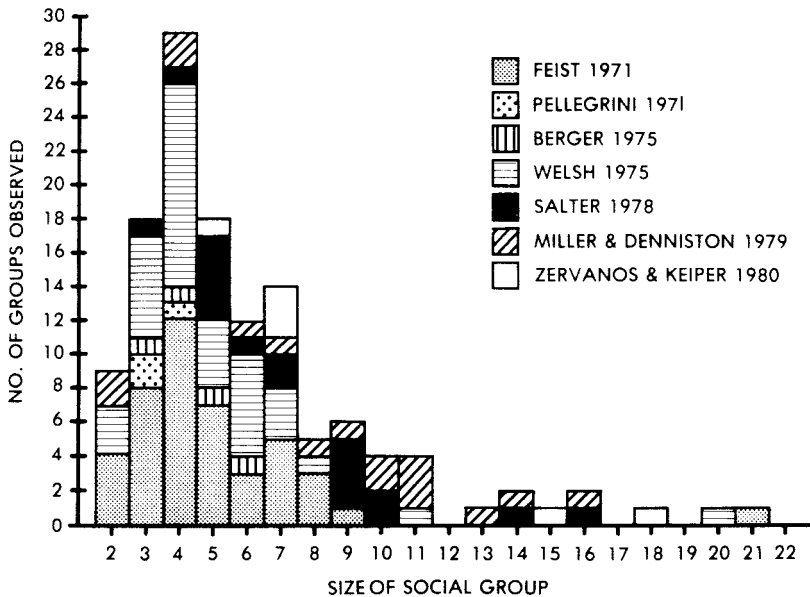


Figure 15.1: Size of feral horse bands observed in a variety of North American habitats. Data represent summer samples from one year of each study.

Harem bands (family bands) typically contain offspring of recent years as well as the adults (see Figure 15.2), thus not all members of a band are reproductively active. Besides the youngsters, family bands commonly contain the harem stallion and approximately three adult mares (range 1–9). Studies have reported the average number of mares in bands range from 1.5 to 5.7 (Keiper 1986). In the Granite Range feral population, Berger (1986) found mean number of adult females per band ranged from 2.73 to 3.67 during his five-year study. Although bands are relatively stable over time, changes do occur and thus females do not remain together for life.

Several kinds of groups can be seen in a herd. Besides the typical family or harem bands, consisting of at least one mare and her recent offspring plus an adult male, occasionally additional males accompany harem bands. Bachelor males often form small, less-stable assemblages of usually 4 or fewer members. Membership in bachelor groups commonly shifts throughout the year. Feist (1971) frequently saw solitary males as well as bachelor groups of up to 8 individuals; the average bachelor unit was 1.8 ($n = 23$).

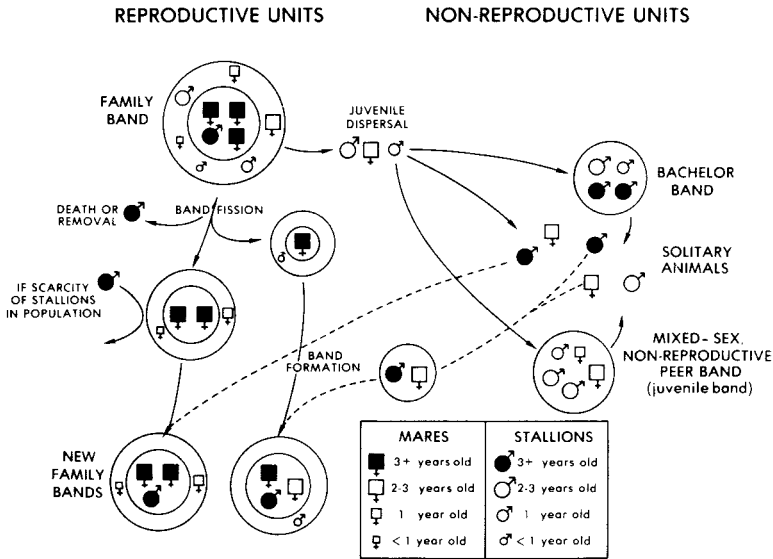


Figure 15.2: Social organization patterns exhibited by free-roaming horses.

Solitary mares sometimes are seen. Occasionally mares and offspring are together as a group without the company of an adult male. This is common when stallions are scarce. Another type of grouping that occurs is the non-family, mixed-sex peer band. Juveniles especially may assemble as a peer band and remain together for prolonged periods (e.g., Baskin 1976; Goldschmidt-Rothschild and Tschanz 1978).

Feral horse populations become structured into (a) reproductive components, consisting basically of harem bands, and (b) non-reproductive components, consisting of bachelor males, solitary females, and non-breeding juveniles or subadults (Figure 15.2). The population remains approximately half female and half male, with adults outnumbering the yearling-foal age class by a factor of 3 or more (Figure 15.3). Although the sex ratio of foals is basically 1:1, among adults the sex ratio can sometimes be slightly skewed in favor of females (Garrott 1990). For example, in Wyoming-Montana, a sample of 270 feral horses was found to consist of 48 percent males and 52 percent females (Feist and McCullough 1975); in Nevada, a similar-sized population of feral horses was composed of 47 percent males and 53 percent females (Green and Green 1977).

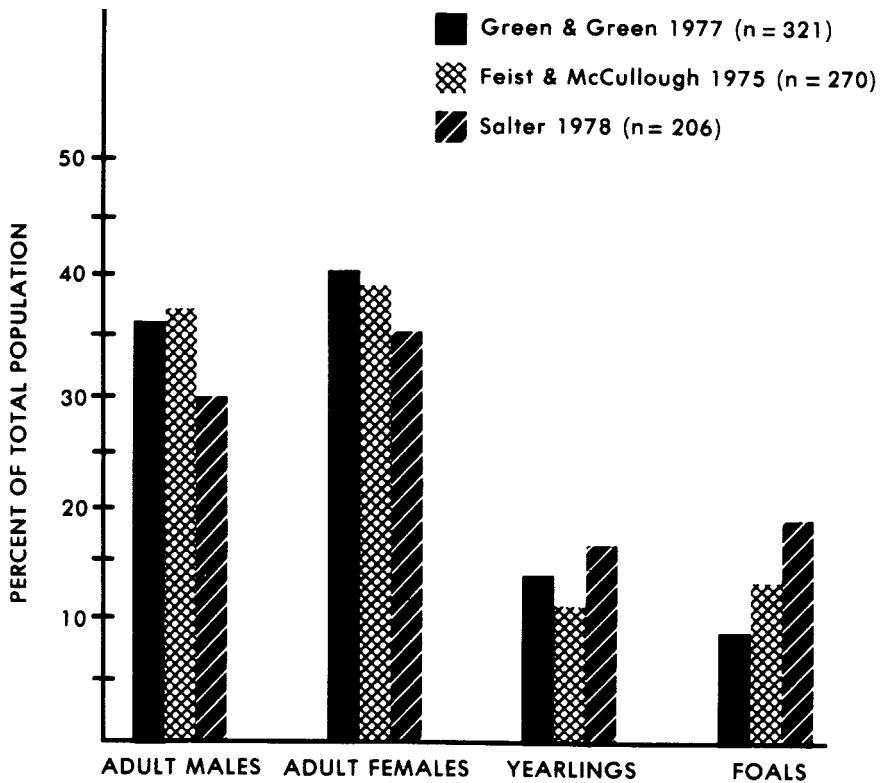


Figure 15.3: Age and sex composition of feral horse populations.

Mortality is greatest early and again late in life; nevertheless, horses have lived past the half century mark under management conditions. Under feral conditions on Sable Island, male life expectancy (5.85 years) was found to be greater than that of females (4.56 years), apparently because of reproductive stresses faced by mares (Welsh 1975). Feist and McCullough (1975) found mortality decreased after the first year of age and gradually increased again beginning about the tenth year. Small bands as well as unstable bands show the lowest foaling rates and survival of young (Welsh 1975).

The reproductive units are the mainstay of herd structure. Unless adult males are scarce, each harem is normally escorted by a stallion, occasionally by more than one. The typical harem consists of 1–4 mares and their offspring of the past 2 to 3 years. The nucleus of the harem band appears to be one or more adult females, not the stallion. Foals and yearlings show

a preference to remain with their mother as well as with other young. And certain adult females show a mutual attachment and preference for each other's company. Thus these companions tend to remain together even without the presence of a stallion (cf. Tyler 1972). The stallion is, therefore, to some degree an adjunct social member of the mare subgroup. Stallions do occasionally show efforts to collect additional mares, and thus a harem band may contain more than one subgroup. Although the stallion is not necessarily the focal point of group affinity, he maintains a patriarchal position in the band and defends the band from intruders. Cooperation is shown the stallion by group members. Feist (1971) and Miller (1980) observed instances where harems seemed to delay their travel to facilitate the reunion of the harem stallion with the band when he was detained or otherwise separated from his group.

Because of herd social organization, most adult females but relatively few sexually mature males fully participate in reproduction. The remaining individuals, including most bachelor stallions as well as juveniles and subadults, are non-reproductive units of the herd. Further development and experience will eventually alter the status of the majority of these. Therefore, the life cycle and dynamic social organization of horses eventually provide reproductive potential to most individuals.

— Emigration and Immigration —

The tendency is for juvenile horses to disperse from their maternal (natal) band. This is especially true for males. Berger (1986), for example, found more than 97 percent of the juveniles between 1 and 4 years of age moved away from their mother's band. Young males may remain solitary for months or even years or join other males in a bachelor group. Young females commonly join harem bands, but may for awhile remain solitary. Sometimes juvenile horses join a mixed-sex assemblage of other young horses that have also dispersed from their natal band (Keiper 1976a; Goldschmidt-Rothschild and Tschanz 1978). Berger (1986) found about 80 percent of young female emigrants remained within view of familiar terrain.

The age at dispersal is variable; it may be influenced by prior experience and environmental circumstances, including social pressures (e.g., by adults of the same sex as the juvenile). Kaseda et al. (1984) noticed a tendency for emigration to occur coincident with the birth of a new sibling. In New Forest ponies, Tyler (1972) found many young dispersed by three years of age; by the time the ponies were four, most had dispersed. On Assateague

Island (Maryland), Rutberg and Keiper (1993) noted that immature feral ponies on average dispersed at two years of age—mean of 20.8 months for males and 24.6 months for females. The relatively low percentage of fillies that do not disperse retain membership with their maternal band. Although not common, some mares rejoin their maternal band after prolonged absence. Harem stallions under such situations react to these mares as they do to the other adult mares, including showing sexual interest upon estrus.

When young males first visit a bachelor band they may be extensively sniffed, nipped, bitten, or chased. They also may be mounted. However, such behavior is not evident when new males are at least 3.5 years of age (Berger 1986). Hoffmann (1985) found young stallions spent most of their first 5 to 6 years in a bachelor group and concluded bachelor groups facilitate a young male's social development in a relatively non-serious environment. Kaseda (1981) noted males castrated in their third year tended to form bachelor groups when released onto range occupied by established harem bands.

Except for juvenile dispersal and the occasional addition or departure of a mare, harem bands are relatively stable. Miller (1980) found the average change in membership in feral bands he observed was 0.75 adult changes/band/year. Emigration by adults is often only temporary. However, the death or removal of a key group member can cause band fission. The subgroups may then join other bands or merge with a solitary adult male to re-organize a harem band.

The tendency in the non-reproductive social groupings is for the more mature individuals of breeding age to eventually leave the assemblage. Typically a male consorts with a solitary female to establish a new band (Keiper 1980). For females, an alternative is to join an established harem. Some lone males may tag along with harem bands. Once tolerated by the stallion and mares, the subordinate male becomes a member of the family band. Multi-stallion situations usually involve just two males, but occasionally up to five. One male is dominant to the others. Some subordinates occasionally breed mares. Welsh (1975), Denniston (1980), Miller (1980), and Berger (1986) noted that subordinate males help protect and maintain the band. Band size of multiple-male harem bands is often larger than single-stallion harem bands in the same population. During their studies, Miller (1980) and Franke Stevens (1990) found more stability in multi-male bands than in harem bands having one stallion.

Established social units are not readily open to admitting strangers. Such is the case for harem bands (e.g., see Feist 1971), bachelor bands (Salter 1978), and mixed-sex peer groups (Goldschmidt-Rothschild and

Tschanz 1978). Age and sex of the approaching stranger can influence the response shown by group members. Harem stallions usually threaten and chase away approaching males. Sometimes serious fights occur between stallions. Occasionally stallions try to herd stray or solitary mares into their band. On other occasions, harem stallions have been observed to drive mares away from their band (Feist 1971). Foals are sometimes allowed to approach with little objection. Band mares sometimes participate with harem stallions in rejecting strange males. And in some cases, band mares reject non-member mares who seek membership on their own or are invited by the harem stallion.

Social Roles

A harem stallion often herds his band together upon the approach of other bands or intruders. Among the males in his band, the harem stallion is dominant and mates with estrus mares of his band. Thus he is typically the sire of the offspring (cf. Kaseda et al. 1982). If subordinate males are within the band, they commonly participate in herding and defense, rarely in mating (Berger 1986). One stallion noticed by Feist (1971) regularly encompassed an old stallion with a female companion into the herding of his band; yet, once the alarm was over, the old stallion and mare were allowed to stray several hundred meters away. Of the 130 instances of herding or driving by stallions observed by Feist, 42 percent occurred to move the group away from another band or stallion, 30 percent were to tighten or direct the movement of the group, 12 percent were attempts to copulate with a mare, another 12 percent occurred to herd away non-members from the group, and 4 percent were attempts to move non-members into the group.

Although stallions attempt to keep adult mares in their band from straying, Collery (1969) found the stallions he observed made little attempt to retain their own fillies. Stallions seem lax about the wanderings of their daughters at puberty; yet Feist (1971) noted one instance where a stallion retrieved an estrous filly. Harem stallions are typically not sexually motivated by the estrous displays of fillies, especially their own offspring, and generally limit their sexual interest to adult mares of their band. Estrous fillies are thus inclined to wander, apparently seeking male attentiveness. The excursion from the original social unit may be brief or in some cases permanent.

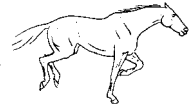
In populations where the number of stallions or their social activities are limited by humans, the herding and defensive role of the stallion in a

band's social structure is assumed by a dominant mare who emphasizes the activities in the stallion's absence (Ebhardt 1957; Zeeb 1958; Tyler 1972). Thus under such situations herding and defense of social units may continue to be seen but are instead exhibited by the dominant female of the social group.

Although ultimately the most dominant member of a band (male or female) can influence the group's activity, initiative and leadership are not shown only by that individual. An activity can be initiated by any member and it often then becomes a group activity through the phenomenon of social facilitation. Tyler (1972) observed that if a subordinate initiated a change in location it usually stopped and allowed a more dominant horse to pass and take the lead. In the feral horse bands observed by Feist (1971), the harem stallion was generally at the front of the band during travel. In 159 instances Feist observed, the stallion overtly took the leadership role in 122 (76.7 percent). When intruders were near, the stallion assumed a position between his band and the intruders. When a family band was alone and undisturbed, Welsh (1973) noticed harem stallions on Sable Island were basically passive and followed rather than led; the senior mare seemed to initiate most movement. Miller (1980) reported stallions and mares each led the band in about half of his observations; when trailing was observed, stallions were behind their band more often (73 percent) than adult mares (19 percent).

One of the major social roles of mares is attentiveness to the needs and welfare of offspring, especially the youngest. Maternal protectiveness is most intense with neonates and relaxes as the foal develops. Aside from direct mother-infant care, band members occasionally exhibit protectiveness over other band members, such as a wandering foal or an incapacitated adult. During daily activities, mares and other members of the social group tend to remain in the proximity of other members of their band. Foals may leave their mother's side temporarily to seek age-mates for play and mutual grooming.

16 Social Attachment



It is not unusual for horses to seek social contact with other horses; yet that social contact is usually directed toward specific herd members. Social attachments (the bonds between individual horses) are evident at various levels in band social structure. In effect, best friends pair off with best friends. Each mother and her young foal exhibit an intimate relationship; juveniles seek specific playmates; mares associate with only certain other mares; and even a stallion's associations are far from indiscriminate. Social companions arranged by humans may not necessarily achieve much social unity even when pastured together if social attachments do not form (cf. Altmann 1951).

In horses, social attachments are the threads that hold social units, such as bands, together (Figure 16.1). Biological advantages of group living can then ensue. The stronger the interactive bonds, the more stable the social grouping and the more the individuals will function physically, temporally, and behaviorally as a unit.

The strength of bonds is affected by changes in reproductive condition, maturation, health, experience, and other factors impinging on the individuals. As one relationship alters in a band, the change may interact throughout the social unit causing other alterations. In the extreme, such as when a key individual is no longer present, the disruption may even lead to group fission.

Once a horse has whatever social attachments are appropriate to its age, sex, and physiological condition, the drive to attain additional social attachments wanes. For example, once a stallion has a harem he rarely solicits new mares (Feist and McCullough 1975; Baskin 1976) and a mare with foal is unreceptive to other foals (Tyler 1972). If a horse lacks an appropriate type of companionship, the individual often shows evidence of the social need and may actively seek or solicit a replacement to fill the void.



Figure 16.1: Even when there is room to spread out, members of social groups show a preference to remain close to one another primarily because of social bonds.

For example, a stallion without a harem actively seeks mare companions; a foal without a foal playmate will usually solicit play and grooming from older horses; a mare or an orphan foal who has lost its respective partner is relatively receptive to a foster relationship; a mare without a foal may occasionally become highly protective of another mare's foal.

Mare-Foal Attachment

A mare's attachment for her foal (mare-foal or maternal attachment) begins to be evident within minutes after parturition. She shows protectiveness and appears anxious if the foal is taken out of her reach. As the foal struggles in its efforts to stand, the mare, even while still recumbent, studies her newborn and utters a consoling quiet nicker as the foal collapses. As the foal nears her forequarters, the mare nuzzles it. With the approach of intruders, the mare stands and shelters the foal beneath her neck or at her shoulder (Waring 1970a,b).

Soon after first standing subsequent to parturition, the mare commonly grooms the foal with a prolonged bout of licking. At this time, the foal is

still wet with amniotic fluid, and the sensory perception the mare gains during this grooming appears important in firmly establishing the mare's attachment to that particular foal. Subsequently, the mare discriminates between her own and other foals.

When the foal is not within reach after parturition, the mare's chemoperception is directed instead to the fetal membranes and fluids at the site of parturition. During experiments when my co-workers and I removed foals temporarily from their mother following birth, the mares spent considerable time sniffing and nuzzling rags that were used to dry the foal.

Upon a reunion of a mare and foal, the mare sniffs the foal, apparently to test or compare sensory cues emanating from the foal to a memory trace of odors associated with perhaps the fluids of the recent parturition and the neonate itself. The mare is noticeably receptive to a foal having the odor experienced at parturition and shortly thereafter. After additional exposure to her foal, the mare begins to show evidence that she can also utilize visual and auditory cues in recognition, especially when the foal is not nearby (e.g., see Wolski et al. 1980). Smelling of the foal is still common once within reach.

Maternal attachment is especially linked to the perinatal physiological state of the mare. Certain hormonal levels are probably involved. At parturition, a mare enters a sensitive period where the formation of a social attachment to a neonate is acute. Normally the mother's bond forms to her own foal; yet if the foal (or its odor) is not accessible to the mare early in the sensitive period, the mare may establish her maternal bond to another foal or to a surrogate. Once the bond is established, the sensitivity for establishing a new maternal bond wanes. If later the foal is lost or dies, the mare becomes depressed and socially disrupted. How overtly the mare shows her attachment to a foal appears directly proportional to the intimacy and length of time she has had with the newborn during the early postpartum period.

Fostering another foal to a mare is far easier soon after parturition than it is a day or two after the mare has affiliated with her own newborn. One of the more effective ways to get a mare to accept another foal subsequent to the establishment of her maternal bond is to drape the strange foal in the hide of her own dead foal. Tyler (1969) noted this technique was successful in an unusual case where a mare accepted an orphan foal after her own 3-month-old foal died in a road accident. Obviously, if either the mare or foal refuse to accept such a new arrangement, fostering fails. Both must be receptive.

Pain can disrupt maternal attachment. The formation of the bond may be slowed. When the bond is already established, the display of maternal

behavior is affected by pain. Thus a mare in extreme discomfort may exhibit little evidence of maternal attachment or will be atypically forceful with her foal. Data are not sufficient to conclude whether maternal attachment differs significantly between multiparous mares versus first-foaling mares; differences in maternal attachment appear to be more the effect of individual mare traits rather than of foaling experience. Young mares as well as old can exhibit strong attachments to their newborn foals. The ability to form postpartum maternal attachments can last throughout a mare's life cycle. One mare I observed had her first foal at the age of 25; displays of her maternal attachment and maternal behavior were consistent with those seen in other mares.

A mare's attachment for her foal continues at considerable strength throughout the foal's first year. The first day or two the mare remains very close to the newborn and only gradually does she relax this protectiveness. As the weeks go by, the mare and foal separate for longer periods and at greater distances (Figure 16.2). Nevertheless, Tyler (1969) found even at 5 months of age, foals spent less than 10 percent of the time more than about 50 meters from their mother. The behavioral activities of mother-foal tend to be synchronous (Rifá 1990). While exhibiting the same behavior, the separation between mare and foal is often less than 5 meters. When the foal pursues play activity with peers the separation between mother and foal is likely to be the greatest (Kusunose and Sawazaki 1984b; Crowell-Davis 1986).

Toward the end of the first year, the maternal bond is generally still evident, but the intimacy between the pair is noticeably reduced. Weaning usually occurs in the few weeks or days before the mare is to foal again. With the subsequent parturition and arrival of a new foal, the mare's attention and social activity shift abruptly to the neonate. She tries to remain relatively isolated with her newborn. The close approach of the previous offspring is discouraged by the protective mare for the first day or two. Within a few days after parturition, the mare and previous offspring may be seen to graze and rest near each other and engage in mutual grooming. Seldom is the previous young allowed to resume nursing. Although the mother's bond to the previous young seems to change most drastically at the arrival of the new sibling, the previous maternal bond may last for years, especially with female offspring, as evidenced by later mother-offspring interactions and affability. The relationship may continue even after offspring begin to have foals of their own. Tyler (1969) found one 13-year-old mare still groomed with her mother even though they were in separate social groups.

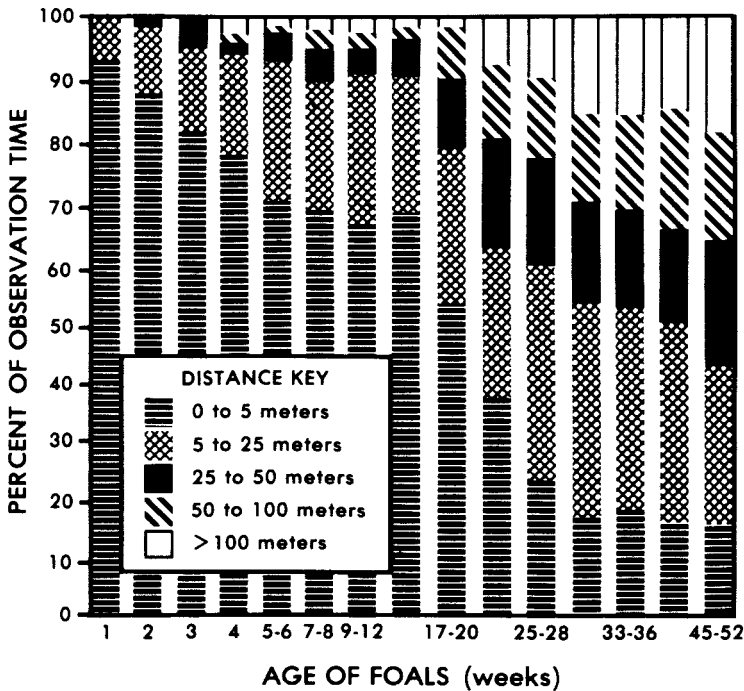


Figure 16.2: Change in the distance between foals and their mother during the first year. (Data from Tyler 1969)

If a new foal is not born the next foaling season, or for some reason the mare does not have a newborn at her side, her attachment to the prior offspring remains very evident and in some cases seems to strengthen. In the latter cases, mares may maternally interact in a more intimate way with their yearling or older offspring than would otherwise occur. For example, nursing may continue and protectiveness may be evident. Shelter seeking by older offspring toward the mare, maintaining proximity, and mutual grooming between mare and older offspring may occur whether the mare is accompanied by a newborn or not.

Sometimes mares without foals of their own adopt newborn foals. Dominant mares and even geldings have been observed to steal a newborn from its submissive mother (Blakeslee 1974). The foal rarely survives unless the adoptive parent lactates and cares for all the needs of the foal. One newborn foal observed by Boyd (1980) was deserted by the mother soon after parturition when it would not follow with the maternal band; the foal was then

adopted by an alien band of adults, consisting of a stallion and five mares. The foal was unable to obtain milk yet attempted to feed on plants by the age of two days. The youngster stayed with the foster band for several days; however by the twelfth day after parturition, the foal was no longer seen and was presumed dead. Eldridge and Suzuki (1976) concluded that in a case they investigated a mare mule adopted the first of twins born to a Shetland mare. The mule apparently came into lactation spontaneously and successfully raised the adopted foal.

—Foal-Mare Attachment—

A foal's attachment for its mother (foal-mare attachment) normally begins after the maternal bond has already become established (Figure 16.3). And although difficult to quantify, the intensity of the mare's attachment for the foal seems greater than the foal's reciprocal attachment for her, at least in the first weeks after parturition. In general, the behavior of the foal appears more opportunistic.

Although the foal's eyes, ears, and chemoreceptors seem to function at or soon after birth (cf. Rossdale 1967a), the foal initially spends little time investigating its environment. However, around 25 minutes after parturition the foal begins to show distinct binocular orientation with the accompanying head movements. Subsequently, within another 10 to 20 minutes, auditory investigation with independent ear orientation becomes apparent. And finally, nosing, sniffing, and licking of nearby objects becomes overt toward the end of the first hour after birth (Waring 1970a). These sensory experiences normally expose the neonate to its mother, who also provides input by licking, nuzzling, and emitting quiet nickers and weak whinnies. The foal exhibits care-soliciting behavior during its increasingly vigorous pre-nursing investigations.

Social interaction with the mother becomes especially obvious beginning in the second hour postpartum. By then the foal has stood and nursing soon follows. Evidence of the foal's growing attachment for the mare is seen in the nuzzling and attentiveness the foal gives the mare as well as its efforts to follow and maintain a position close to her. As intruders approach, the foal begins to seek shelter close to the mare. When the mare becomes recumbent before discharging the placenta and groans in discomfort, the foal may circle her attentively and nuzzle her head and forequarters. In addition, the foal may respond to the mare's vocalization with a weak whinny or other sound (Waring 1970b).

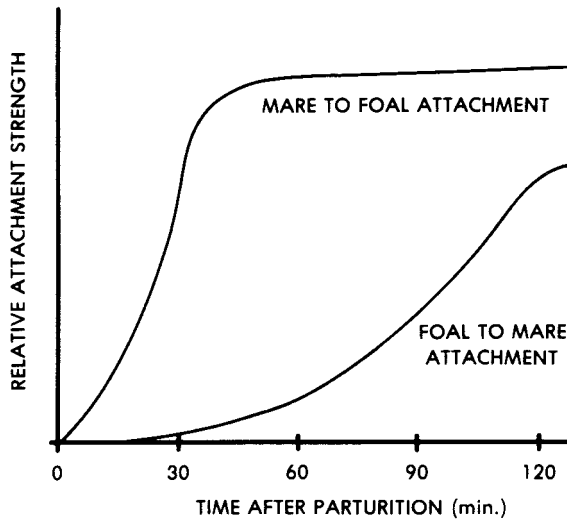


Figure 16.3: Schematic representation of bond development between mare and newborn foal following parturition.

As the relationship continues, the foal's attachment to the mare appears to strengthen. The longer and more intimately the foal associates with the mare, the more it shows a desire to be exclusively with her, and the less likely it will seek a relationship with other organisms. The sensitivity of the foal to this initial social attachment occurs especially in the first few hours after birth. Fear responses to strangers become increasingly evident after the second hour postpartum if the foal-mare attachment has begun to develop. The foal's initial tendency to follow large moving objects becomes more and more restricted, becoming a response shown only to the object of its social attachment. Visual cues especially aid the foal in locating its mother (e.g., see Boyd 1980).

Tests for distress behavior as a measure of foal-mare attachment have not been completely revealing. Although mares show overt excitement and anxiety, many foals when temporarily separated from their mother in the first few weeks show restless behavior more akin to disorientation than distress. Houpt and Hintz (1981) noted the vocalization rate of experimental foals temporarily separated from their mother peaks toward the end of the first month, suggesting foal-mare attachment is greatest at that time.

Both the maternal bond and the foal-to-mare bond are important for the well-being of the foal and help keep the pair together. The foal-to-mare bond limits spatial separation and establishes the foundation for later social development. It provides the foal with a source of nutrients, shelter, security, and guidance. The reciprocal mare-to-foal bond assures adequate parental investment to maintain close protection of the foal, to prevent spatial separation, and to provide for the needs of the foal. It is by a combination of the two bonds that the foal survives and may itself someday produce offspring.

Malfunction of the social attachment between foal and mare can occur. Tyler (1969) reported some foals born in the woodlands of England inappropriately formed their attachment to a tree. In one instance, the foal showed considerable attraction to a particular tree on the day of birth. It remained close to the tree even when the mare moved several meters away. The foal nibbled the tree, walked around it, and moved to and from it. In cases where the foal completely ignores the mare, the mother eventually deserts it. Boyd (1980) reported such an example. However, in the case Tyler (1969) observed, a successful foal-mare relationship eventually formed.

Alteration of the social experiences of newborn foals can affect normal social attachment and subsequent behavior. Grzimek (1949a) reared a foal in isolation from other horses until 64 days of age. His experiment gave early insight that social imprinting does exist in horses and that early social attachment and experiences greatly affect later social behavior. The foal at 64 days avoided and showed fear of other horses; it made every effort to remain close to human handlers. The foal's attachment was to people, not to its own species.

Foals isolated from other horses and reared on a system where milk is mechanically dispensed also show defects in normal social behavior. They prefer human caretakers to equine companionship when later tested and fail to interact with the social signals of their own species (Williams 1974).

How maternal and social deprivation during development affect adult behavior, such as reproductive behavior, is not yet clear for horses. The effect may be major if the individual identifies with a foster species as has been shown in other farm animals by Sambraus and Sambraus (1975). Complete disruption would be unlikely if the foal had established some early attachment to its own species. Blakeslee (1974) reported such a case. A foal orphaned at eight days of age was isolated from other horses and hand-reared. Although it developed an attachment to its new human mother, the colt successfully joined into a group of yearling males when released later. Houpt and Hintz (1983)

compared the behavior of six orphan foals to that of six mother-reared foals and found no differences in time spent grazing, standing, recumbency, or in locomotion; yet the orphan foals did scratch more. When each foal was placed alone in a novel environment (paddock), the mother-reared foals appeared more stressed, were more active, neighed more often, and defecated more often than orphan foals.

Peer Attachment

Social affiliations that form between horses of similar social or age class are called peer attachments. They are best-friend relationships, for example, as seen with certain mares or young horses with favorite playmates.

Peer attachment normally does not develop in foals until a number of days after birth. The protectiveness of the mare and the reluctance of the foal to approach other horses initially limit social contact to the mother-young relationship. During the first two to three weeks, foals seldom interact with other foals, and when they do, they mostly stare at each other or may briefly touch. Only after their third week, Tyler (1969) noted, do foals begin to move further from their mother. Interactions with other young then become more frequent. Early interactions are primarily investigative with approaching, sniffing, and nibbling. Progressively foal-to-foal interactions become playful. The foals chase one another, often rearing, kicking, and bucking as they gallop. In quiet moments, the foals begin to spend considerable time grooming each other.

As mutual grooming and playful interactions develop between foals, it becomes increasingly evident that the foals are developing social attachments outside of the mother-foal relationship. Foals progressively seek peer companionship. And although several potential partners may be available, foals pair off more and more with a particular partner. The companions often remain close during grazing, resting, and other activities.

The peer relationship that develops can be with a sibling or with another foal either within or outside the social band. Occasionally trios form. Weeks et al. (2000) noticed foals tend to associate with the foal of their mother's preferred peer associate. Partnerships can be between colts, between colt and filly, or between fillies. Colt partners alternate mutual grooming with long bouts of play fighting. Filly-colt and filly-filly partnerships are characterized by mutual grooming almost exclusively, with only rare interludes of playful chasing (Tyler 1969). In studies of

Icelandic horses, Thórhallsdóttir et al. (2000) and Sigurjónsdóttir and Thórhallsdóttir (2000) noted play and allogrooming partners were commonly of the same sex-age group, had kinship ties, and were of similar rank in the dominance hierarchy.

Bonds that develop between immature horses may or may not persist into adulthood. When juveniles disperse from their original companions, previous social ties often appear to be severed; yet, long-term information is sketchy. Perhaps previous ties promote social contact and renewed companionship later, especially among mares (cf. Arnold and Grassia 1982).

Some immature horses disperse from their family group in the company of a companion rather than alone. The pair may then join another social group. Observations where lone females have been affiliated with a group of males (e.g., see Feist 1971; Salter 1978) appear to be the result of a young female joining an existing male group in the company of her previous colt companion. Likewise, mixed-sex juvenile bands (e.g., see Keiper 1976a; Goldschmidt-Rothschild and Tschanz 1978) may form, in part, by juvenile pairs joining an established juvenile group or serving as a nucleus for the formation of a new group.

New social contacts provide an opportunity for new peer attachments to develop. The ties apparently remain weak among males in a bachelor group, since such groups are normally not very stable. However, other social groups by comparison are more long term, suggesting better developed peer attachments. Regardless of group affiliation, the tendency is for non-reproductive individuals to eventually shift their social situation until they become a reproductive participant in the herd social organization. To achieve such a status may require more than one change in social group and corresponding changes in social bonds. Mature stallions tend to eventually shun male companions. For stallions, the overt social attachments once with a harem are primarily heterosexual and paternal relationships. Mares, however, can develop and maintain close relationships with other mares without interfering with reproduction.

Throughout the life cycle, mares tend to pair off with other mares. In adulthood, such peer attachment may be a carry over from previous juvenile companionship or more often is a relationship that develops anew in maturity. Some mare-mare companionships can be mother-offspring pairs that have persisted when female offspring remain with the maternal band or have rejoined it. In most cases, however, mares tend to pair with mares of similar rank and age (Wells and Goldschmidt-Rothschild 1979). Harem bands commonly are stable because of well-developed peer attachments. In a band,

a mare may exhibit attachment to all or several peers; yet, it is not uncommon for mares in a group to exhibit a single best-friend relationship.

Mare companions tend to remain together in most activities. They graze together, rest together, and groom together. When separated, they become distressed and whinny loudly in an effort to make contact and become reunited. If kept apart, the desire to rejoin a companion may persist for many months. Tyler (1969) observed that a mare separated from her companion in the fall became reunited with the companion when released in the spring even though the remaining mare had joined with another group during the winter.

Heterosexual Attachment

Attachments between horses of opposite sex primarily for interactions of a sexual nature are heterosexual attachments. Often the partners interact as if in a peer relationship; yet underlying the relationship is sexual attraction. Few studies have focused on these bonds in horses. Although sexual promiscuity often characterizes horse management situations, the social system that typically develops under free-roaming conditions concentrates sexual behavior specifically toward companions within the band. Both stallions and mares appear to choose their sexual partners; even under management conditions, considerable biases and preferences for mates are shown. Mutual attraction facilitates the development of long-term heterosexual attachment. The consort arrangement between mare and harem stallion becomes more overt when the mare is in estrus because of the stallion's increased attentiveness and closer proximity. Nevertheless, the bond persists between successive estrous periods and likely began when the partners first accepted each other as band members.

Heterosexual attachment may begin as peer relationships among first-year foals. Mutual grooming between a colt and filly is common, Tyler (1969) observed; but often the colt becomes rough and the filly withdraws. The colt sometimes follows and initiates further grooming, but soon roughness may again cause the filly to avoid the colt. In some cases, a filly returns to a colt, initiates grooming, nibbles at his head and legs, and in a playful manner rears or initiates chasing. Such colt-filly pairs often establish an intimate relationship and they remain very close to each other. When another filly approaches the pair, the colt may sniff her or remain indifferent, whereas the filly companion usually threatens the intruder. When another colt approaches, the two males occasionally interact in a brief challenge before the colt returns to his companion.

Relationships involving first-year foals usually lack sexual overtones seen in older horses. Mounting attempts by first-year colts are feeble and rarely associated with erection of the penis. Mounting is not unique to colt-filly relationships; colts mount any companion, including the mother. When penis erection does occur in colts, the young male is usually resting, play fighting, or engaged in mutual grooming. Fillies exhibit no overt sexual displays until their first estrus as yearlings.

At puberty, social contacts of young horses often shift, and sexual behavior begins to characterize interactions between horses of the opposite sex. Dispersal from the maternal band often occurs at this time. New male-female encounters are often brief, with the sexual advances of the male being most obvious. Unless in estrus, the female reacts negatively to direct contact with a stallion, except for mutual grooming. Young females when in estrus solicit to males, including mature stallions and sometimes to first-year colts. Harem stallions seldom show an interest in the young mares, especially from their own band, and seldom tolerate sexual activity by nearby males, thus young females and males usually disperse. It may take months or even years for the young individuals to find a compatible companion of the opposite sex.

Once a mare and stallion mutually accept the presence of the other, their relationship can develop into a long-term heterosexual bond. Mutual grooming and sexual interactions seem to facilitate bond development. Body conformation, coloration, and even mannerisms may be important factors in sexual attraction and therefore may be involved in bond formation. Once the bond forms, the pair remain together spatially and socially throughout the year. In some cases, a solitary stallion locates a receptive mare, and the two start a new band. Sometimes a mare joins an established harem band after gaining the interest of the stallion and the tolerance of the other group members. And occasionally a stallion will join a mare band that either has no harem stallion or where he has been able to supplant the previous harem stallion.

In most cases, heterosexual bonds develop between the stallion and all adult mares in the band. Cases where a stallion drives off a mare from his band (cf. Feist 1971) are possibly instances where heterosexual attachment did not develop. More often, mares are coveted and defended by the stallion. The stallion retrieves mares when they wander too far away, places himself between the harem and intruders, and often drives (herds) the harem to safety. Mares exhibit their mutual attachment for the stallion by facilitating and accepting heterosexual social contact with him only (not with

bachelors or nearby harem stallions), awaiting his return when he has been detained, and responding at a distance to his vocal inquiries (e.g., see Feist 1971; Baskin 1976).

Paternal Attachment

Harem stallions associated with family units normally extend their herding activities and protectiveness to young as well as to the mares within the band. Stallions sometimes retrieve foals that have wandered and can be seen to protect foals from pending danger (e.g., see Feist 1971; Boyd 1980). Foals greater than three weeks of age show interest in stallions; they nibble them, and young colts even play fight with the gentle and indulging stallions (Tyler 1969). Thus there is evidence that the stallion has some paternal attachment toward offspring. Mares most often handle care and protection of their own foal and seldom does the need arise for the stallion to intervene; yet when the stallion herds or drives his harem, the young of the band are included in the stallion's maneuvering of the social unit.

As the young in a band mature, the harem stallion reduces his overview of foal activities. By the time a colt or filly reaches sexual maturity, the stallion passively allows dispersal. And in some instances, especially with colts, the stallion aggressively encourages a juvenile to leave the band (Jaworowska 1976). Few juveniles return; yet occasionally dispersal is temporary or does not occur, and the stallion may subsequently allow a young mare or submissive colt to return or remain as a member of the family band. Berger (1986) found father-son interactions often continued after colts left their natal band; stallions played with bachelor males that were their sons about 650 percent more often than they did with non-related bachelors.

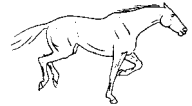
Interspecies Attachment

Interspecies companionship occasionally exists in horses under management conditions (e.g., see Olberg 1959). In such cases, a horse usually shows an attachment for a particular companion animal whether it is a chicken, goat, dog, human being, or other organism. Interspecies companions commonly replace peer relationships normally shown to other horses. The foal Grzimek (1949a) raised in isolation from other horses exhibited a generalized preference for familiar human handlers. A dependency on having the companion nearby may develop. In the absence of the

companion, the horse involved tends to exhibit restlessness or signs of social deprivation. A performance horse (e.g., a race horse) in unfamiliar surroundings is considerably more relaxed when with its companion than without it, and owners are cautious not to lose the possible effect the companion has on the horse's well-being and subsequent performance. In days of old, scoundrels who stole the companion animal (i.e., "got your goat") gave competitors a considerable advantage.

Interspecies companionships seem to develop in horses as a result of experience with the exotic animal during a prolonged situation where horse companionship is not available. The interspecies companion, therefore, becomes a surrogate for equine companionship and subsequently a long-term bond develops.

17 Home Range and Territoriality



Horses restrict their movements to a specific home range as well as to a limited distance from social companions. Furthermore, horses show a tendency to defend an area around themselves and their social unit. Age, sex, physiological state, social status, and environmental situation appear to influence home range, social distance, and the somewhat subtle forms of territoriality. Considerable plasticity seems to exist in the species; thus population characteristics, home range size, and territoriality can vary noticeably between one study and another (Table 17.1).

Home Range

The home range of an individual horse normally coincides with the home range of other members of its social group. It is the geographical area covered during day to day activities. The major requirements within the home range are water, food, and shelter. Shelter includes shade, wind breaks, and retreats from such things as insect pests. These resources may be shared with horses of other social units, thus the home ranges of more than one band may overlap.

As seasonal changes occur in the abundance of food, water, insects, and the need for shelter, the movements and habitat utilization patterns of horses adjust as well. Thus in times of abundance of food and water, little movement may be required to satisfy the needs of the horses. Or, as happens in southern Nevada after heavy rain or snowfall, bands shift temporarily to areas of abundant food until surface water dries up, then the horses return to the portion of their range which contains a permanent water source (Green and Green 1977). Elsewhere, when food becomes scarce near water holes, horses may have to forage in one area and travel as much as 16 km to obtain water (Feist and McCullough 1976). Ponies that seek shallow bays or ocean surf during the insect season subsequently avoid entering the water during winter (Keiper 1979a).

Table 17.1: Population Characteristics and Social Patterns of Feral Horse Populations								
	Wassuk Ridge (Pellegrini 1971)	Granite Range (Berger 1986)	Pryor Mountains (Feist 1971)	Grand Canyon (Berger 1975)	Sable Island (Welsh 1975)	Shackleford Banks (Rubenstein 1978)	Stone Cabin Valley (Green and Green 1977)	Boreal Forest (Salter 1978)
Population Characteristics								
Population size	12	149	270	78	240	104	703	206
Population density/km²	0.1	2.3	2	0.2	6.3	11	0.5	1
Age Structure:								
Adults, %	75	46	58	66	64	61	77	53
Juveniles, %	17	28*	29	23	21	21	14*	29
Foals, %	8	26	13	11	15	19	9	18
Activity Areas:								
Group home ranges (average), km²	31	7–25	15	23	3	6	52	8
Group territories (average)	?	no	no	no	no	3 km²	no	no
Social Patterns								
Group Composition:								
Harems								
Average size	3.3	3.1	5.0	4.5	5.5	12.3	5.3	7.7
Size range	3–4+	1–7	2–21	3–6	2–8+	—	2–15	3–17
Bachelors								
Average size	?	4	1.8	1.8	—	2.6	?	?
Size range	1–7	1–17	1–8	1–3	1–?	1–?	1–4	1–6

Continued on next page

Table 17.1: Population Characteristics and Social Patterns of Feral Horse Populations								
	Wassuk Ridge (Pellegrini 1971)	Granite Range (Berger 1986)	Pryor Mountains (Feist 1971)	Grand Canyon (Berger 1975)	Sable Island (Welsh 1975)	Shackleford Banks (Rubenstein 1978)	Stone Cabin Valley (Green and Green 1977)	Boreal Forest (Salter 1978)
Social Patterns								
Mixed-sex peer group	?	?	yes	yes	?	yes	?	yes
Solitary males	yes	yes	yes	yes	yes	yes	yes	yes
Band Stability:								
Adult female group changes, %	0	50	7.6	0	some	10.8	1.5	6.8

*Yearling age class only.

Modified from Rubenstein 1978

Home ranges of free-roaming horses vary greatly in size and are correlated not with group size but with resource availability. Home ranges vary, for example, from 0.8–10.2 km² (200–2500 acres) in the New Forest of England, from 2.6–14.4 km² in the boreal forest of western Canada, from 0.9–6.6 km² on an island habitat off Nova Scotia, and from 3–78 km² in arid regions of western United States (see Table 17.2).

In most home ranges, resident horses rarely use all parts of the range equally. Some areas are used extensively and other sites are seldom visited. Thus bands have smaller areas within their home range where they spend most of their time. Such areas are often called core areas and can vary with season. Berger (1986) found at low altitudes (range of fall-winter-spring) the core areas of bands averaged 6.7 km² in the Granite Range of Nevada. At high-altitude areas (summer range) band core areas averaged 25.1 km². He found over the five-year study, harem stallions showed clear fidelity in their annual use of home range areas, but bachelors were often not faithful to core areas from year to year.

Table 17.2: Variation in Home Range Size for Harem Bands, Bachelor Bands, and Solitary Males at Several Locations

Home Range Size (km ²)	Location	Source
Harem Bands		
0.8–10.2	New Forest, England	Tyler 1969
2.6–14.4	Alberta, Canada	Salter 1978
0.9–6.6	Sable Island, Canada	Welsh 1975
2.2–11.4	Assateague Island, USA	Zervanos– Keiper 1980
3–32	Wyoming– Montana, USA	Feist 1971
8–48	Arizona, USA	Berger 1977
11–78	Nevada, USA	Green–Green 1977
17–33	Nevada, USA	Pellegrini 1971
5–60	Nevada, USA	Berger 1986
Bachelor Bands		
12.4	Alberta, Canada	Salter 1978
8–30	Nevada, USA	Berger 1986
Solitary Bands		
4.7	Alberta, Canada	Salter 1978
5.2	Nevada, USA	Pellegrini 1971
8–35	Nevada, USA	Berger 1986

Daily rhythmicity in activity patterns and habitat use sometimes is apparent. In such cases, horses tend to carry out maintenance behaviors at nearly the same time and place within the home range from day to day (Tyler 1969; Welsh 1973; Rubenstein 1978). Nevertheless, unpredictable and irregular patterns do occur periodically, and some groups seem to have little or no schedule for their site visits and activities.

Occasionally an individual or even a group will leave the previous home range boundaries and take up residence in a new range. The reason is not always apparent. Young horses that commonly disperse from the parental band as yearlings or older face a shift in home range; sometimes, however, they join a band whose range partly overlaps that of the original band. Some horses shift home ranges repeatedly. Old and decrepit horses may account for some of the shifts (Feist and McCullough 1975). Sometimes mares shift at the time of foaling. In other cases, an entire band may shift its home range because of human-caused environmental disturbances, such as seismic testing (e.g., see Welsh 1975). Thus the geographical area any individual horse uses during its lifetime (life range) is considerably more than its home range at any particular stage in its life.

If a horse is taken from its home area (whether a stable or open range), it exhibits a tendency to return home once released (cf. Grzimek 1943b; Williams 1957; Tyler 1969). Some horses have successfully returned over distances of 15 or more kilometers. Homing succeeds in returning an individual not only to familiar habitat but also to its social companions. Undoubtedly, stress is then considerably reduced. Tyler (1969) observed an instance where a yearling colt was taken about 6 km from his mother and previous range. After castration the colt was released. Five days later he was back with his mother on the original home range. Ponies allowed to graze on the Chincoteague National Wildlife Refuge in Virginia are annually rounded up and herded from Assateague Island to Chincoteague Island where culls are made for public auction. Subsequently, the remaining ponies are herded back into the water and released. Keiper (1979b) found the released ponies not only re-form the same social groups but they also re-occupy their previous home ranges.

During day to day activities, horses tend to move only a short distance from companions before moving back toward them or awaiting their arrival. This spatial limit is called maximum social distance. Several factors, such as pending danger or strength of social attachment, affect the limit seen from one occasion to the next. In the feral population Feist (1971) observed, the maximum social distance between members of a band was seldom more

than 23m. Baskin (1976) found separations of as much as 50m but only under non-alarmed conditions. Maximum social distances are the least between mares and their foal of less than a week of age. In 94 percent of the observations Tyler (1969) made of foals in their first week, the spatial separation between mother and foal was less than 5m. As foals mature, the maximum social distance increases.

Early experience of a positive and diverse nature seems to boost the security and confidence level of young horses, thus the distance they separate from mother or peer companions can be relatively large. The foals my research team (Waring 1972) had given extensive early handling were clearly inclined to drift away from the mother in their eagerness to explore. The tendency for foals to normally limit their activities to a circle around the mother was emphasized by Baskin (1976). As the band moves to a new site, the mares move ahead of the young; but once grazing resumes, the youngsters drift somewhat ahead of the group before circling the mares in their activities.

—Territoriality—

In most feral horse herds that have been studied, territoriality or defense of an area against conspecifics is typically to prevent intrusion of a zone around one or more individuals rather than defense of a fixed geographical site. Most horse habitats do not have abundant and even distribution of all resources, thus it is common for horses of one band to share watering, feeding, and shelter sites with other bands. Overlap of home ranges of different bands is frequently observed (Feist 1971; Tyler 1972; Welsh 1975; Green and Green 1977; Salter 1978; Miller and Denniston 1979; Berger 1986). Yet, to the extent possible, bands mutually avoid each other. Terrain can assist in isolating bands, such as the parallel ridges and deep valleys that Pellegrini (1971) found in western Nevada.

If one band encounters another, any defensiveness shown usually appears to be an attempt to maintain the integrity of the band rather than to defend a site. To obtain access to a resource, however, one band may attempt to displace another band and encounter some defensiveness from the band already at the communal resource.

Dominant stallions are often the individuals active in aggressive encounters between bands; however, if the stallion does not take the initiative other members of the band may, such as a dominant mare or subordinate stallion (e.g., Miller and Denniston 1979). Feist (1971) reported that the feral bands he observed usually maintained a spatial separation of 100m or more, and around water holes an approaching band would wait at a distance until an

earlier group had departed. Subordinate bands tend to avoid more dominant bands; a dominant band can, therefore, displace a subordinate group or individual (Berger 1977; Miller and Denniston 1979). Marking dung and urine appears to enable a stallion to advertise his presence and may facilitate spatial distribution; overt marking of range boundaries per se has not been observed.

Not only do horses defend a zone around their band, but also each individual horse maintains some degree of personal space around itself, and a mare typically challenges those who approach her foal. A mare's defensiveness associated with her foal is greatest in the neonatal period and wanes as the foal matures. As horses develop, they begin to show a tendency to keep at least some distance (i.e., individual distance) between themselves and their nearest neighbor. Feist and McCullough (1976) noticed that threat displays were shown if one horse came within 1.5m of a horse that would not tolerate close association at that moment (Figure 17.1). Individual distances appear to vary with the sex, age, social status, experience, environmental context, and mood of the interactants. Personal space in horses seems to center on the head or forequarters; yet research is needed to determine the complete 3-dimensional contour of personal space around a horse's body and factors that affect it. Individuals sharing a strong social attachment may exhibit little, if any, individual distance to each other under most circumstances.



Figure 17.1: Head-extended threat display often shown by a horse in an effort to maintain its personal space. (Photo courtesy of P. Malkas)

Oftentimes spatial distribution within and between bands is maintained not by overt defense but instead by avoidance. Baskin (1976) noticed the spatial separation between individuals within a band was typically 5–6m; whereas, between groups that shared a common feeding site the separation was 40–60m.

Territoriality, social attachment, and social dominance are often interrelated. For example, a dominant animal socially attached to a group will defend the space around that group; yet if social attachment is weak or dominance status low, evidence of territoriality may also be poor. Harem stallions are faced not only with defending their mares and maintaining the integrity of their band but also with retaining their dominant social status, at least among males. Bachelor males seek opportunities to breed with mares, to herd them away, or to supplant the harem stallion.

Another example of the interrelationship that can occur between territoriality, attachment, and dominance is seen when occasionally a mare attacks a stallion when he mounts her peer companion (i.e., peer attachment “best friend”). Peer attachments often occur between horses of similar rank. Peer companions can display a degree of defensiveness, if not possessiveness, with regard to their social partner.

Certain environmental situations seem to facilitate the isolation of one band from another onto exclusive-use home ranges (Gates 1979; Zervanos and Keiper 1980) or onto territories per se where defense of the site is shown (Rubenstein 1978). In most habitats where feral horses have been studied, exclusive-use home ranges do not occur; however, it is not unusual for bands to utilize different core areas (areas of intensive use). In arid environments, two or more bands may utilize a common water hole as well as some of the same feeding sites; the bands remain spatially separated, yet their home ranges overlap. When resources are abundant and evenly distributed in a habitat, home ranges need not overlap. Under such environmental circumstances, bands may then partition the landscape into adjacent exclusive-use home ranges. Subsequently, each band can limit its movements to its own area and may even defend that area against encroachment by other bands.

The narrow barrier islands along the eastern coast of the United States seem to provide habitat where bands can establish and maintain exclusive-use areas. On Assateague Island, Maryland, for example, Zervanos and Keiper (1980) noticed some home range overlap when all data were plotted; however, when the infrequent excursions were excluded from the distribution plots, they found that bands maintained themselves in separate and adjacent home ranges arranged sequentially along the length of the island.

It appeared as if each band might be occupying a territory, but no overt defense of the sites has been seen. Nevertheless, Rubenstein (1978; 1981) has seen overt defense of exclusive-use areas on Shackleford Banks (island habitat along the North Carolina coast); the defended areas provide all the needs of the resident band. At the time of study, the population was more dense than most horse habitats (Table 17.1). Two-thirds of the harem groups maintain the well-defended, non-overlapping, permanent territories spaced sequentially along one end of the elongated main island.

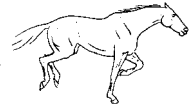
Territorial boundaries on Shackleford Banks seemed to coincide with subtle geographic features, such as a patch of fresh water, a tidal inlet, or a row of low sand dunes. Large dung piles were distributed throughout the territory and did not appear to be boundary markers. Boundaries ran the width of the island from the ocean to the sheltered back waters. The boundaries of the approximately 3 km² territories shifted no more than 15–20m over several years of observation (Rubenstein 1978 and personal communication).

As soon as a territorial stallion on Shackleford Banks detects that an intruding male has entered his domain, he charges and a fight normally ensues (Rubenstein, personal communication). The resident invariably wins and the intruder retreats. Most of the time, territorial stallions and their harem have little outside interference or competition; the overall energy cost of maintaining a territory on the island seems quite low. The narrow island reduces exposed boundaries and visual monitoring of the territory is easily accomplished. Only from May through July do males sometimes raid territories apparently in search of mares; otherwise bachelor males and neighboring stallions with harems rarely cross boundaries of territories. A notable exception occurred during an extreme drought. Twice a stallion herded his harem across the territorial line to drink from a neighboring water hole after theirs had become dry. During each excursion, the stallion restricted his band to the sand flats and proceeded only at low tide.

When the behavior patterns of territorial bands are compared to non-territorial harem bands, additional differences appear. Territoriality seems to provide some adaptive advantage for maintenance activities and for reproduction. Territorial bands on Shackleford seem to exert less grazing pressure on the various patches of vegetation within their exclusive-use range, returning to a patch every 10–14 days compared to less than 7 days for bands with overlapping ranges. Territorial harems consist not only of more adult females but also have been the only groups that have consistently shown a size increase. Non-territorial bands, possibly in response to

more frequent contacts with other bands, show smaller average individual distances during and immediately prior to the breeding season. Territorial stallions spend relatively little time driving their band and keeping the band clustered, compared to non-territorial harem stallions. Whenever a territorial stallion does round-up his mares, he directs his activity more toward females low in the female dominance hierarchy than toward high ranking females; the higher ranking females are more involved in mutual grooming with the stallion. Non-territorial stallions treat harem mares more equally (Rubenstein 1978).

18 Social Dominance



Whenever two or more horses are in a group, whether in confinement or free-ranging, they will establish between each other a dominant-subordinate relationship. Methods for determining dominance rank are many; Baer et al. (1979) compared several and found agreement tended to be for the most dominant and most submissive horses, rankings for middle positions varied between methods. Thus, it is not easy to compare one report on dominant-subordinate relationships with another.

For the most part, the system of social dominance that develops in horse groups approximates a linear hierarchy (cf. Estep et al. 1993). In theory, the number one individual (i.e., alpha) is therefore dominant over all others in the group, the last individual (omega) is submissive to all, and those in middle positions of the hierarchy are in turn dominant to some and submissive to others. Yet, sometimes non-linear (e.g., triangular) relationships occur (cf. Gröngröft 1972). An example is shown in Table 18.1a where the animal placed sixth in the overall grazing rank order nevertheless showed dominance over the third but not over the other horses in the hierarchy. Occasionally two or more horses appear equal in dominance (note PM and MM in Table 18.1c). Keiper (1976a) found a case of equal dominance in a bachelor band of three young males.

Social position affects to varying degrees nearly every aspect of life in groups (Kolter 1984). Most horse researchers have noted some evidence of an established rank order among all social group members, including mares and immatures. Relationships within a group may for awhile be stable yet may change as individuals come and go from social groups or as individuals grow, age, or gain experiences. Feist and McCullough (1976) found dominant-subordinate relationships clearly evident in bachelor groups, and the alpha male position of each group was overt.

Table 18.1: Dominant-Submissive Interactions During Grazing, Drinking, and Leisure in a Group of Six Mares on Pasture

Mares	SUBMISSIVE						Total Threats	Number of Horses Threatened	Apparent Rank Order	
	PR	LTS	PM	MM	CS	CK				
(a) Grazing										
DOMINANT	PR		4	11	6	12	7	40	5	PR ↓ LTS ↓ PM ↓ MM ↓ CS ↓ CK
	LTS	2		5	6	20	9	42	5	
	PM				2	7	2	11	3	
	MM					6	9	15	2	
	CS	1					11	12	2	
	CK			4				4	1	
(b) Drinking										
DOMINANT	PR			1	1		1	3	3	PR ↓ LTS ↓ PM ↓ MM ↓ CS ↓ CK
	LTS					4	16	20	2	
	PM				1	2	1	4	3	
	MM						5	5	1	
	CS						1	1	1	
	CK			5				5	1	
(c) Leisure										
DOMINANT	PR		1	13	9	4	3	30	5	PR ↓ LTS ↙ ↘ MM ↔ PM ↙ ↘ CS ↙ ↘ CK
	LTS			6	6	14	12	38	4	
	PM				5	3	1	9	3	
	MM			5		2	2	9	3	
	CS							0	0	
	CK			2				2	1	

Body wt, kg 475 475 500 450 430 340

Age, yr 17 8 18 21 11 3

Data from McPheeters 1972

Dominance among mares did not appear as obvious and seemed dependent upon circumstances. Rank order, social attachments, and aversion relationships within a group form an interactive network that is extremely complex; from moment to moment, the social situation changes depending on the individuals involved, the nearness of others, the environmental context, and so on (Kolter and Zimmermann 1988).

Establishing and Maintaining Rank

A horse gains a dominant position over another individual by exhibiting enough superiority that the other individual yields or withdraws. The interaction may involve only displays, such as kick threats or bite threats, with no direct physical contact; or it may be mostly pushing with head and neck bumping; or it may be violent with kicking, striking, and biting; or avoidance may occur and be almost imperceptible as being an interaction. After one or more interactions and usually within a day or two after first being together in a group, the relationship between any two individuals becomes relatively fixed. In future encounters, fighting rarely occurs. If the subordinate individual does not yield on its own accord, a threat gesture from the dominant will normally cause withdrawal (Figure 18.1). Both individuals know their status. With the reduction in aggressive interactions, social life becomes more efficient.

In a mixed-sex, varied-age herd that had been together at least 8 months, Montgomery (1957) noted 488 dominant-submissive interactions. Of these, 74.7 percent were bites (two-thirds being threats only), 10.3 percent involved passive avoidance, 8.3 percent were head bumps, and 6.2 percent were kicks or kick threats.

Studies of dominance should be careful to distinguish dominant aggressiveness from submissive defense. Wells and Goldschmidt-Rothschild (1979) found in their study that bite threats were given toward subordinates but kick threats tended to be used as a defensive reaction against dominant animals.

Social dominance can be exhibited in a wide variety of daily activities and is not unique to any sex or age class. Within a social unit, one gender does not necessarily dominate another; females may rank higher than males in some cases and males may rank higher than females in others (cf. Houpt and Keiper 1982). Feeding competition is one situation where dominant-submissive relationships can be seen. A dominant will supplant a subordinate at a preferred grazing site or at a feed bucket. Researchers oftentimes provide a source of food to increase interaction frequency so as to more easily determine rank order (e.g., Grzimek 1949d; Tyler 1972; Gröngröft 1972; Sereni and Bouissou 1978; Houpt et al. 1978).

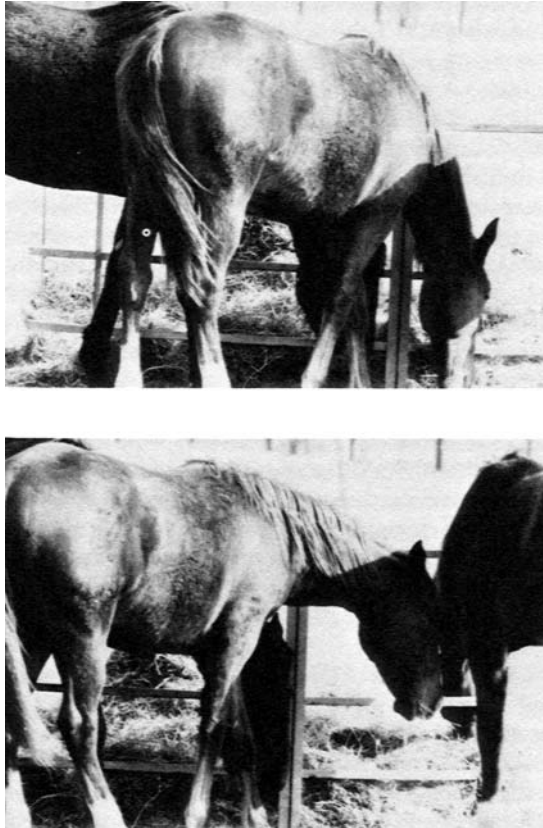


Figure 18.1: Social dominance interaction where a horse high in rank (behind) displaces a subordinate (foreground).

Rank order during free grazing does not appear to change when the interaction frequency is increased by providing additional food (Clutton-Brock et al. 1976). Glendinning (1977) found that small groups of orphan foals sequentially followed a rank order when fed with a milk dispensing machine.

Dominance relationships among horses can also be seen in such activities as drinking, resting site selection, breeding, sequential rolling and marking behavior, as well as during herd movement. Although aggression often helps establish dominance, aggressive acts diminish once a rank order is established, thus group life becomes more efficient. Rutberg and Greenberg (1990) noticed mares peak in aggressiveness soon after reaching full body

size and firmly established their position in the social order, thereafter they progressively reduce their involvement in aggression as they grow older.

Although the general trend remains, a rank order for one type of activity (e.g., feeding) may not be as obvious or exactly the same in another situation (e.g., drinking and leisure in Table 18.1). A horse that is persistent in getting its way while grazing may show far less tenacity for access to water; thus, another horse may make it yield its place at a water trough but would be unable to make it yield its grazing site. Some horses may threaten other horses in primarily one activity, such as grazing, and be passive or submissive in other situations (note CS in Table 18.1). Clutton-Brock et al. (1976) found in summarizing their field study of Highland ponies that threats occurred throughout the day at an average rate of 1.9 per horse per hour.

No matter what the activity, threats are not equally distributed among subordinates; most individuals threaten certain horses more than others without any apparent correlation to nearness of rank. Rutberg and Greenberg (1990) found subordinate mares with foals received aggression more often than subordinate mares without foals.

Once social dominance is established in a group, the rank order remains quite stable over time (Tyler 1972). Among foals, stable relationships become evident by six months of age. Death or removal of a horse does not cause a change in the dominance relationship of those remaining. Even when a herd is divided, Grzimek (1949d) found the hierarchy in the new groups similar to that observed in the larger herd. Stability seemed greatest at the top and the bottom of the scale. Although some dominance shifts did occur when the herd of 29 yearling colts was divided, Grzimek noted that the average change amounted to only two places up or down the expected order based on the rank in the original large grouping.

Factors Influencing Rank

The influence of factors such as age, weight, and height have been studied with regard to dominant-submissive relationships. Age appears to play some role in gaining a social position but is not necessarily decisive (Grzimek 1949d). More often the effect of age in a social group is most evident in the lower part of the hierarchy where the immature members tend to fill the bottom positions (Tyler 1972). Wells and Goldschmidt-Rothschild (1979) found that rank order based on head threats was highly correlated to age in a herd of Camargue horses ($r_s = 0.988$, $n = 25$, $P < 0.001$). Body size seems to be an important factor in gaining a social position; yet, exceptions can

be seen (note CK and PM in Table 18.1). Hechler (1971) found that in the three pony herds he studied, a statistically-reliable ranking system could be determined by using weight and height; Ellard and Crowell-Davis (1989) found weight, height, and age each correlated significantly with rank in draft mares. Tyler (1972) concluded, that among the higher positions in a hierarchy of ponies, size was more important than age in determining social position.

Among feral horses, Keiper and Sambraus (1986) concluded kinship did not appear to have any affect on dominance rank. However, in a study of Belgian horses, Araba and Crowell-Davis (1994) found rank order among foals, both before and after weaning, was positively correlated with the rank order of their dams (Spearman's rho, $P < 0.02$).

The influence of gender on social dominance has also been investigated. Stebbins (1974) concluded that the interrelationship between gender and age would result in a social rank order as follows: stallion, mare, gelding, male juvenile, female juvenile, male foal, and female foal. In feral herds, a harem stallion must out-compete other stallions to obtain and retain a harem band. And within a band, an adult stallion often occupies the alpha position, both in harem bands as well as in bachelor groups (e.g., Feist 1971; Jaworowska 1976; Salter 1978). Berger (1977), however, noted in one of the feral horse bands he observed that the harem stallion was subordinate to the two mares in the group. In non-feral, domesticated herds, it is often observed that males do not necessarily rank above females during maintenance activities. Montgomery (1957) found females occupied intermediate positions among geldings in the herd of eleven he tested during feeding situations. Houpt et al. (1978) found similar variability when mare, stallion, and gelding dyads were tested at a single feed bucket; in their study, they found stallions during the breeding season were dominant over high-ranking mares but submissive to mares low on the mare hierarchy. In the semi-feral herd studied by Wells and Goldschmidt-Rothschild (1979), stallions were subordinate to adult mares with foals in most situations, except when a stallion exhibited driving behavior; the only adult mare without a foal held an intermediate position between the two high-ranking stallions. In social groups containing geldings, sometimes a gelding will occupy the alpha position (and even assume the role of harem stallion) with mares and stallions subordinate to him (e.g., see Stebbins 1974). In a study of social units (3 feral and 3 non-feral) each consisting of at least one stallion and several mares, Houpt and Keiper (1982) reported mares or geldings were alpha individuals and not stallions.

The length of time a horse has been with a band may affect its position in the dominance hierarchy. In many other species, newcomers are typically at a disadvantage in an established social group and must work their way up the hierarchy; they typically hold lower positions. Wells and Goldschmidt-Rothschild (1979) postulated that one of the reasons the older stallion in their study was not top ranking was because he was the newcomer. Assertiveness became more and more evident in the stallion as time went along.

Prior experience and physical condition, including endurance, undoubtedly play a role in determining an individual's dominance status. In most cases, harem stallions dominate bachelors; yet, infirm harem stallions eventually yield their position to younger challengers. A band of a crippled stallion observed by Feist (1971) was eventually split into two bands by other stallions. Ebhardt (1957) witnessed a violent fight between an older harem stallion and a less experienced young challenger. Though the young stallion appeared outmatched by the strength and skill of the old stallion and though it repeatedly was in serious danger, it continued to fight. When the endurance of the older stallion finally waned, the young challenger drove off six mares from the harem and the battle ended. Berger (1986) noted that most males he observed lost harems to rivals through aggressive contests; however, old stallions occasionally may lose a harem for lack of attentiveness. One 26-year-old, for example, slept as his band moved out of view; the stallion subsequently searched for over 5 hours covering 16 km to find his missing mares (who, to his good fortune, had not been taken by another stallion).

Along with other factors, temperament plays a role in social dominance. Aggressive and persistent horses regardless of weight, height, sex, or length of residence in a band achieve higher ranks than more passive individuals (e.g., see Ebhardt 1957; Blakeslee 1974; Araba and Crowell-Davis 1994). Tyler (1969) observed numerous cases among New Forest ponies where small, young, but aggressive mares were dominant over larger, older mares. She even saw a very aggressive 5-year-old mare arrive as a stranger in a new area and within two weeks the newcomer was dominant over all other mares. Stebbins (1974) found some mares in her study became more aggressive once their foal was born; thus through that summer those mares showed temporary dominance over, for example, geldings and mares without foals. Boyd (1980) found no evidence of rank order change after foaling in the feral horses she observed. Estrus has not been found to alter a mare's rank; however, a mare who immigrates into a new band during estrus may consort

with the harem stallion and, because of his proximity, initially receive few challenges from others in the band.

It has been suggested that dominance may be related to the learning ability or intelligence of a horse (e.g., see Blakeslee 1974). Nevertheless, Rudman et al. (1980) found no correlation in the experiments they conducted.

—Influence of Rank Order on Daily Activity—

On the Pryor Mountain Wild Horse Range, Feist (1971) observed what appeared to be a relationship between dominance and rolling activity. In all instances where some or all members of a group rolled in succession, the dominant stallion was the last to roll. Stebbins (1974) noted some tendency for rolling to occur sequentially through social facilitation, but in her study she found no correlation of rolling to the dominance rank order.

Foals normally rank low in dominance; however, while near their mother they share the mare's dominance rank. For example, the foal of a dominant mare will not be threatened by mares subordinate to the mother provided the foal is close to the mother; yet when the same foal moves several meters away, it is threatened by the subordinate mares (Tyler 1972). Immature horses often exhibit snapping (tooth-clapping) when approached or challenged by adults other than their mother. This submissive gesture is especially obvious as foals approach the dominant stallion.

Dominant stallions tend to urinate or defecate on top of the eliminations of subordinate males. Feist and McCullough (1976) found this strictly adhered to in bachelor groups, but in harem bands some exceptions were seen. In a mixed-sex peer group, consisting of one mare and six males, they noted when the mare or a low-ranking male defecated the rest of the band in ascending order of dominance would in turn add their excrement. Compared to other males, harem stallions show a greater tendency to mark excrement they have seen another horse deposit, especially that of mature mares and especially during the breeding season (Turner et al. 1979; 1981). Stebbins (1974) observed that during encounters between stallions the subordinate male preceded the dominant male when scent marking on the feces of a female. Under feral conditions, dominant stallions from two different bands often interact at large well-established fecal piles (e.g., see Feist 1971; Welsh 1973; Salter 1978).

When one band encounters another, a high-ranking representative (commonly the dominant stallion) from each group comes forward to interact. The other members of the two groups usually wait the outcome of the

interaction and abide by the outcome without entering the conflict themselves. Under conditions of an exceptionally scarce water supply, Miller and Denniston (1979) observed when one of 16 bands attempted to displace another band from the remaining communal water source, the dominant stallion of the approaching band led the aggression in many instances; yet sometimes a single female, a male-female pair, or a pair of males led the attack. The harem stallion was not necessarily a member of such aggressive pairs.

There appears to be no correlation between interband dominance and the number of adult males in a band; however, there is a direct relationship between band size and the number of bands dominated (Berger 1977; Miller and Denniston 1979). Bachelor males, whether alone or in groups, tend to rank low in interactions with other groups; the status of the same males improves after acquiring mares (Miller and Denniston 1979).

Social characteristics within a group, such as nearest neighbors and mutual grooming, can be influenced by dominance rank. For example, Clutton-Brock et al. (1976) observed in a small herd of Highland ponies that most time is spent close to individuals of similar rank and age. They also observed that the ponies groomed most with individuals of similar rank and age. Pauses in the grooming sessions were initiated more by the higher-ranking partner. The higher-ranking member of a grooming pair was more likely to start grooming in the Highland pony herd. On the other hand, Tyler (1969) found dominant ponies she observed initiated only 38 percent of mutual grooming bouts when partners were observed to start asynchronously.

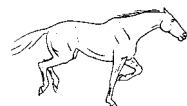
During long-distance travel, the position individuals take in the moving column is, in part, affected by social dominance. Any individual in a social group may initiate group movement; yet Tyler (1969) noticed that if the initiating individual was a young animal it soon stopped until a more dominant pony had overtaken it. In groups with two or more mares, the more dominant mare proceeds ahead of the other mares, each accompanied by their foal followed in turn by the next oldest offspring. The position the dominant stallion takes appears to be influenced by environmental circumstances. Feist (1971) found stallions were either leading or noticeably driving their band in 76.7 percent of the band movements observed; the stallion was at the front in 66.7 percent of the cases. When other bands were nearby or disturbances were present, the stallion took a rear position and herded the band away. In multi-stallion groups observed by Miller (1980), the alpha stallion often led a single file column followed sequentially by the more subordinate males.

Social dominance influences reproduction in various ways. The lowest ranking males of a herd seldom have an opportunity to breed mature mares during estrus. Usually fertile mares in estrus are tended and mated by the dominant stallion. In free-roaming horses, an adult mare is seldom alone and is part of a harem band; the harem stallion is her consort. Sexual harassment may be less for harem mares than for solitary ones because the proximity of the dominant stallion would intimidate other males. Mares tend to reject subordinate males but occasionally are seen to approach, nuzzle, and even present their genital area to dominant stallions (Salter 1978). Stebbins (1974) saw many instances where dominant mares may influence reproductive success of subordinate mares by chasing young mares away from courting stallions. Stebbins also noticed mares with foals commonly were dominant over mares without foals; Keiper and Sambraus (1986) found no such trend. Whether there is a cause-effect relationship of dominance on pregnancy rate or foaling rate needs further study. Asa et al. (1979) reported stallions in their study usually selected the dominant estrous mare for copulation whenever more than one estrous mare was present.

In feral situations, one harem stallion performs most matings; nevertheless, secondary stallions in a band as well as outside males achieve some matings. Feist and McCullough (1976) found seven out of eight successful copulations were by harem stallions. In single male bands, Miller (1979) also found harem stallions did not necessarily accomplish all matings; males outside the band were observed to do as much as 28 percent of the matings with harem mares. In harem bands with more than one stallion, Miller noted the dominant male participated in only 54 percent of the observed matings.

Just before giving birth, mares sometimes separate temporarily from their band. Blakeslee (1974) found the dominant mares she observed tended to spend more time at the birth site and did not rejoin their group as soon as did subordinate mares.

19 Agonistic Behavior



Overt aggression invariably captures the attention and interest of even the most casual observer. One of the most dramatic and awesome spectacles of horse behavior is certainly spirited combat between two stallions. Nevertheless, associated with aggression are a variety of other behavioral patterns, such as alarm, threats, submissive gestures, avoidance, and flight; yet these are often disregarded or overlooked. To the serious observer, however, all of these behaviors have relevance and are encompassed by the term agonistic behavior. For illustrations of these behaviors consult Chapter 3, Chapter 20, and other pages in this book as well as the paper by McDonnell and Haviland (1995).

Alert, Alarm, and Flight

As an initial response to an environmental stimulus (e.g., a new object, a sound, or an intruder), a horse becomes alert and attempts to orient the sensory receptors of the head toward the stimulus source. Recurring or minor sounds may cause only an ear to rotate while the horse continues, for example, to rest or forage. Yet, often, stimuli are of sufficient type and intensity that the horse raises its head and investigates more extensively. Other activities, such as walking or chewing, may cease. The alert posture, consisting of an elevated neck with intently oriented head and ears with nostrils sometimes slightly dilated (Figure 19.1), may induce similar alertness in neighboring horses. By looking, listening, and smelling, they test the situation. If the source of stimulation is deemed unobtrusive after the initial investigation, the horses may resume their previous activities.

If an alerted horse continues to be stimulated, additional investigative and agonistic behaviors occur. If recumbent, the horse gets onto its feet.



Figure 19.1: Alertness, showing elevated neck and intense orientation of the ears and eyes.

The vigilant horse may begin to exhibit restlessness, as if concerned about the stimulus. A nicker is sometimes emitted, especially by mares to their foal. Slight elevation of the tail may occur. The body and limbs are readied for potential locomotion. Spatial separation between social companions may become less. If the stimulus is moving away, watchfulness with little locomotion occurs. If the stimulus is approaching, withdrawal may occur. If the source of stimulation is stationary, the alert yet curious horse may begin moving in that direction with ears and head oriented directly toward the stimulus. When the stimulus is approached with apprehension, the direction of travel is circuitously angled rather than a direct approach. Social companions usually proceed to investigate together as a tightly clustered group, with one or two more dominant individuals in the lead. Feist (1971) found the dominant stallion of feral bands led such investigations; group members were close behind and attentive to his cues.

With increased stimulation and arousal, alarm may be exhibited. The eyelids open widely exposing white scleral tissue, the neck elevates fully, the nostrils dilate, and direct motion toward the stimulus ceases. Defecation and nervous pawing may occur. One or two members of a group may then emit an explosive blow of air through the nostrils; the sound may be repeated. The entire group shows full arousal. The lead horse, in a jerky manner, may then

step in the general direction of the stimulus as if to entice or challenge while still at a safe distance. The horses nervously stare at the suspicious object. Commonly the horse leading the initiative produces another noisy blow of air as it trots a few steps circuitously in another direction and again stares.

When the source of stimulation remains a threat, withdrawal commences. Horses sometimes withdraw in stages, stopping periodically to stare at the stimulus. If the stimulus remains stationary and thus becomes less obtrusive, a hesitant return to investigate may occur. The flight response and the flight distance depend on the intensity of the situation. In a group of unhandled horses, Zeeb (1963) found standing and walking humans were avoided, keeping a distance of 3–5m. When the same horses were confronted with a man on all four limbs, the distance of avoidance increased; yet, if the man remained motionless, they approached cautiously to investigate. Exaggerated movement by the quadruped-like man caused flight to occur. The horses as a group would withdraw at a trot for 100m.

As the horse nearest an alarming stimulus pivots away from the stimulus and takes flight, its companions do so also. Foals remain at their mother's side. Sometimes allelomimetic behavior (mutual mimicry) within the group increases the flight response, causing more alarm and greater withdrawal than might otherwise be shown. Allelomimetic behavior may also occur earlier when the group makes its approach and investigates. Perhaps a single horse would not approach as closely as a group.

Once group withdrawal commences, one individual may direct the flight by leading or by driving the group from behind. The horse that initiates the flight may be in front for awhile, but in prolonged flight that position may change (Berger 1975). Feist and McCullough (1976) found the dominant stallion displayed the leadership trait in the feral bands they observed. When flight was because of an intruder, the stallion was usually positioned between the band and the intruder as movement continued.

Flight occurs with a speed, manner, and distance relative to the stimulus and situation. Reactions are swift and reflex-like when surprise occurs; in such cases, alert, alarm, and flight may appear to occur simultaneously. After the initial response, a horse usually appears to regulate its actions so as to meet the needs of the situation and not to be excessive in its flight response. When a horse reacts to an object it has approached closely with its outstretched head, withdrawal may be primarily a quick retraction and elevation of the neck and head, often swinging them to one side. In such a manner, a horse withdraws from a kick or strike attempt by another horse. A sting on the muzzle or sudden bad taste while eating will also cause

this response. When startled by something in front or to one side, a horse turns quickly and moves away a meter or more; rearing may occur if the forelegs are threatened. When threatened from behind, the response is a lunge forward, sometimes with a lowered pelvis. A horse sufficiently startled by a touch to the hindquarters will give such a forward lunge response as well as raise and turn its head to investigate.

Some well-known equine responses given in agonistic situations have received special names, such as balk, bolt, buck, buck-jump, and shy. These examples are flight responses. Refusal to move, at least toward something suspicious, characterizes a balk. A sudden locomotor dash is typical of a bolt. When a horse shies, body parts (e.g., head and neck) quickly withdraw from the suspicious object but the feet usually only shift slightly and typically to one side. Buck, buck-jump, rear, kick, strike, and other motor patterns are described and illustrated in Chapter 3.

In most cases of flight where locomotion occurs, the trot is the gait used in withdrawal. Simple avoidance occurs at a walk. When extremely alarmed or pursued, a horse may use a gallop. Foals use a gallop more readily than grown horses when in flight. In responding to intruders, Feist and McCullough (1976) observed feral bands moved 50 to 100m before stopping to watch the intruder again. They also noted that if the stallion remained calm the rest of the group, though originally alarmed, would soon calm down. In the feral bands observed by Berger (1975), flight covered a distance of 30 to 110m when not pursued; nervous mares initiated most flight responses of the bands (14 out of 16). Foals were among the last members of a band to take flight, and nearby bands merely became curious when another band took flight rapidly.

When physically restrained, foals and older horses often use a series of pushing, pulling, and twisting maneuvers in an attempt to struggle free. Repeated bouts may occur, but eventually struggles subside. Horses with prior experience of restraint often yield sooner than naive individuals. Foals a few hours of age as well as older horses can be taught to remain calm under human restraint.

Shyness in horses varies between individuals and appears to be an effect of both heredity and prior experience. Fear responses can be reduced through habituation by repeatedly exposing a horse to inconsequential stimuli. Grzimek (1944a) tried to experimentally demonstrate differences in timidity of horses by measuring delay interval and approach reaction of horses to pictures, other horses, and so on. Under his experimental conditions,

he found no appreciable difference between sexes, breeds, or test situation. Individuals 11 years and older showed more reluctance to respond than did experimental subjects 10 or younger.

Aggression

The aggressive displays of horses range from relatively mild, subtle acts to intensely violent displays—depending on the circumstances. Not only horses, but man and other annoyances can be aggressively challenged (cf. Zeeb 1959a). Normally horses are conservative and display the minimal amount of aggression the situation requires. Thus, threats are far more common than violent contacts. Berger (1977), for example, found only 24 percent of the 1,162 intraband aggressive acts he recorded around a water hole involved anything more than a threat or mild push; a similar 22.6 percent occurrence of violent-type aggression was noted by Baskin (1976) for horses competing for winter pasturage.

The more mild forms of aggression include the laying back of the ears, lowering and extending the head, shifting the hindquarters toward an opponent, and using the body to block or push the opponent. The first sign of displeasure or aggressive intent is generally the posteriorly directed ears compressed against the skull. The ears-laid-back display accompanies aggressive acts; at the peak of those acts, the ears are most compressed.

When the object causing aggression is in front of a horse, the horse tends to react initially using a head gesture. Whereas, when the object is behind, the horse may instead shift the hindquarters toward the object.

A body block is used by a mare with foal as well as by a harem stallion to screen a foal or harem, respectively, and thus to intimidate an intruder who is nearby. Mild pushing with head, neck, or shoulder occurs to displace an opponent, for example, from a feed bucket.

Mid-level aggression is displayed by threats to bite, strike, and kick as well as extended-head gesturing with sideward swing or up and down motion. Vigorous tail switching and even slight hopping motions with the hindquarters may occur prior to kick threats. Threats to strike or kick sometimes involve head and body bumping between opponents and are often accompanied by harsh vocal squeals. In a strike threat, one or both forelegs are lifted off the ground; and in kick threats, one or both hindlegs are gestured. Yet both displays lack complete effort and are restrained. Saddle horses, when being readied for a ride, sometimes seem to protest by

stomping the ground with an abbreviated strike threat. Knocking using a hindfoot is a similar aggressive gesture of protest.

Bite threats are the most common of the sudden mid-level aggressive displays. They may consist of a head swing with slightly opened mouth or consist of a nipping motion toward an opponent using an extended head as well as neck (Figure 19.2). Such gestures are delivered toward annoyances in front or to the side of the aggressor. In most cases, it is apparent that the aggressor is only threatening because no serious effort is made to achieve contact or to actually bite the other horse. Bite-like gestures are often given toward flying insects that have landed on the horse's forelegs, back, barrel, or flanks. Bite threats are often directed toward an opponent's head, shoulder, or chest and occasionally their forelegs. When the aggressor is behind the recipient horse, such as when a stallion is about to drive a herd member, a bite threat is directed at the hindquarters; this causes forward motion in the recipient as it flees.



Figure 19.2: Bite threat. (Photo courtesy of P. Malkas)

Although opening the mouth to grip an opponent's mane is common in play fighting (Schoen et al. 1976), seldom is non-play aggression displayed by holding onto an opponent. Nevertheless, Feist and McCullough (1976) reported one instance where an immature male displayed submissive snapping to a harem stallion, but the stallion with ears laid back reached out and bit the immature on the shoulder. The stallion, fixed in this position, held onto the skin of the shoulder for about one minute before releasing the young male.

The low neck, head-extended display of aggression given by an approaching horse generally causes withdrawal (avoidance-retreat) and thus displacement of others, such as from food or water. The so-called snaking pattern, with extended head and lowered neck to or below horizontal, is used by stallions and dominant mares to herd or drive others. Biting may be feigned. Nodding or swinging the neck accentuates the display.

High-level aggression involves serious efforts to bite, strike, or kick an opponent; physical contact is attempted. Yet, even then, some gradation in effort appears. Sometimes the attacker makes contact but refrains from putting full energy into the onslaught. At other times, the attacker does put forth full effort. Contact can result in wounding the opponent, especially when the aggressor uses extreme effort. An opponent, however, is usually cautious enough to dodge most attacks. Unless both individuals are intent on a fight, direct contact often fails.

When a fight ensues, combatants attempt to subdue their opponent by strategically placed bites and by knocking the opponent off balance. Maneuvers are usually forceful and swift. Hindleg bites and circling sometimes occur (Figure 19.3). At other times, fights emphasize rearing and biting at the opponent's head and neck (Figure 19.4).

Occasionally horses use the forelegs alternately in a brief attack when in contact with an opponent. This boxing-like pattern often occurs when two fighting horses rear on their hindlegs and proceed to make contact with the head and forelegs. The alternate striking pattern with rearing is sometimes used against intruders, such as canids.

Horses a few hours of age and older are capable of aggressive acts. Unsuspecting human handlers are sometimes seriously injured by a kick from a neonatal foal. Skillfulness in using agonistic behaviors increases with experience as well as through physiological and morphological maturation.

Environmental context, dominance status, as well as gender and age affect the type of aggressive display presented. In studying the social relationships of a herd of Camargue horses, Wells and Goldschmidt-Rothschild (1979) found mares gave most aggressive head gestures to their yearling offspring and to stallions but fewest to their foal.



Figure 19.3: During rapid circling and hindleg biting one combatant has managed to knock his opponent off balance. (Photo courtesy of P. Malkas)



Figure 19.4: Intensive aggression with rearing and head biting. (Photo courtesy of P. Malkas)

Mares gave most kick threats (including aggressively orienting their rump) to their foal and yearling as well as to stallions (especially during copulatory attempts). Stallions, yearlings, and foals used head gestures

within their own age group and with younger animals, whereas they tended to use hindquarter threats against individuals dominant to themselves. Foals, but rarely yearlings, directed kick threats to their mother. Kick threats were common in play of non-adults; head threats were not. The general conclusion of the researchers was that head threats are given to subordinates in situations such as grazing, shelter seeking, and maintaining individual distance; kick threats, on the other hand, are especially common in contexts such as play and copulation and tend to be used defensively against dominant individuals.

Aggression can occur between and within any gender or age class. Prolonged aggression, however, seldom occurs among foals, except as play. Adults sometimes seriously threaten young horses (e.g., see Kolter and Zimmermann 1988). Foals that attempt to approach or suckle mares other than their mother are usually rebuffed by the mare's show of force. Horses harried by others may redirect aggression to nearby subordinates. Stallions can be especially threatening to subordinate horses when in conflict situations during sexual interactions. Fatal maulings can occur. Tyler (1969) witnessed stallion attacks on young mares and foals. On one occasion, a recently released stallion had been driving for over 30 minutes a mare accompanied by her foal. The mare was not in full estrus. Eventually the foal got separated from its mother; the stallion rushed to it, grabbed its neck with his teeth, and shook the foal until the mare intervened. Duncan (1982) also reported where recently released stallions maimed or killed foals; one stallion killed six foals immediately upon release. Yet, when kept permanently with a breeding herd over the subsequent two years, the stallion killed no more. Keverling Buisman and van Weeren (1982) reported Przewalski's stallions in captive situations have been seen to show serious aggression toward young males as well as females; one stallion, after taking over a harem, fatally mauled three non-kin colts. And in the San Diego Wild Animal Park, a Przewalski's stallion recently introduced to a group of mares caused the death of two newborn foals sired by a previous stallion; when long established in a group, the marauding stallion never before or after showed infanticidal tendencies (Boyd 1986).

Fights between adults of the same sex can often be intense. Mares occasionally attack other mares. Dominant mares sometimes become aggressive toward subordinate mares who approach a stallion while in estrus. Furthermore, kick fights lasting 2–3 minutes can occur so as to determine dominance when strange mares challenge each other (e.g., see Tyler 1969). Fights between stallions can be highly ritualized and at times may be violent.

Interactions Between Stallions

Interactions between stallions commonly involve ritualized displays, unlike other forms of agonistic behavior in horses. Conflicts between mature free-ranging stallions function in part as a spacing mechanism, inducing harem stallions and their respective social unit to remain distinct and separate from other stallions and their bands. Agonistic interactions also provide a mechanism for bachelor males to test the ability of a harem stallion to maintain his status and to retain mares.

Ritualization has provided a means for horses to interact and to demonstrate dominance without resorting to violence (Tschanz 1979); therefore, separation often occurs without serious physical combat and severe injury having taken place. Interactions between two harem stallions tend to be less intense than interactions between a harem stallion and a bachelor (Salter 1978).

The ritualized interactions of stallions take place as recurring sequences of the following stages: (i) staring while standing, (ii) body posturing and locomotor displays, (iii) close olfactory investigation, (iv) squeals, fore-quarter threats, and pushing, and (v) fecal pile displays. Sometimes one stage is omitted or shortened to move on to the next stage. Separation may occur following any phase or after several repetitions of the sequence. Separation after a fecal pile display is most common. Interactions between stallions may last only a few minutes or for more than an hour. Salter (1978) observed one interaction to last nearly 1.5 hours when a harem stallion interacted with a group of young bachelors.

The initial stage, the stare, involves one or both stallions standing and looking toward the other while some distance apart. The alert posture is used with ears forward. Whinnying, tail switching, and pawing sometimes occur. Stallions often study passing bands or those grazing nearby. A slight approach may occur before again standing and watching. Salter (1978) concluded that about half of all harem stallion interactions do not proceed beyond this stage.

If stallions do interact further, they proceed to display their status and intent using visual signals. With neck arched, head tightly flexed, ears forward, and tail elevated, dominant stallions approach each other or move parallel in the same direction. The head and neck may be moved up and down, causing the mane and forelock to be flung about—thus accentuating the display. The forelegs are lifted high, and all hooves are forcefully placed on the ground in an exaggerated trot. Sometimes the forelegs are swung forward in the motion of a strike threat. When the stallions are still apart and

each displays from the vicinity of separate fecal piles, they may proceed to paw and sniff the pile at their location, add their own feces, then again sniff the pile. The stallions may continue to interact after the visual display or conclude the discourse and move off in different directions.

When interactions continue, visual displays are followed by a stage of close investigation where each stallion smells and exhales at the nostrils and muzzle of the other. Olfactory investigation may proceed to other parts of the opponent's body, often following a sequential check of neck, withers, flank, genitals, and finally the rump and perianal region.

At some point during the olfactory investigation, one or both stallions suddenly squeal and threaten the other with a bite threat or strike threat while slightly rearing. Biting and striking may continue to be attempted but are usually blocked by counter maneuvers of bumping and pushing with the head, neck, and shoulder. The forelegs are sometimes used alternately in a bout of striking motions. Biting of the hindlegs may occur causing the opponent to tuck and swing away the hindquarters. Occasionally the hindquarters are used for bumping. A kick attempt with one or both hindlegs as well as the infrequent chase tend to be reserved for the end of a bout of active fighting. In the initial sequence of aggressive exchanges, the body contact phase tends not to be prolonged or as intense as subsequent sequences.

The stallions may then proceed to a nearby communal fecal pile and continue to interact. The fecal piles of feral horses tend to be 1–2m in diameter yet may be over 7m (23 ft) in length (Feist and McCullough 1976). In unison or taking turns, the stallions sniff the pile, defecate upon it, then turn and sniff again. Sniffing of the opponent's feces is typical. Feist and McCullough (1976) found no relationship between which stallion defecated first and which either initiated or won the interaction; however, in "mock fights" between immature or bachelor males, the dominant always defecated last. Welsh (1973) concluded that on Sable Island the defending stallion was first to mark the pile, and the stallion of the band that originally approached and initiated the interaction was the last to defecate.

If the stallions still do not separate after the fecal pile ritual, another sequence begins repeating the various stages or phases of the overall interaction. With each sequence, one phase may be emphasized more than another and the intensity of combat may increase. Additional sequences occur until one or both stallions withdraw with their band. Members of a stallion's band seldom participate in the interactions but remain in the vicinity until the fight is over.

Violent, non-ritualized fights occasionally occur between stallions. Such fights begin by one or both stallions suddenly charging with little or no preliminary posturing. Bites, foreleg strikes, and hindleg kicks are given in earnest. Bloody wounds and broken bones can occur. Soon one individual withdraws and may be chased as well as bitten by the winner. Such fights seem to occur most often when an alien male rapidly approaches a band of another male or is suddenly discovered harassing a mare of the band.

Most aggressive interactions between stallions are the result of bands coming too close together or because of disputes over male status and conflicts over mares. Of the 83 aggressive interactions Feist (1971) observed which involved at least one stallion (harem stallions, lone bachelors, or bachelor group), 37 seemed to occur to maintain linear spacing between groups or a lone bachelor, 18 seemed to be the result of males challenging the position of harem males, 12 were associated with attempts to steal a mare, 10 occurred within bachelor groups as dominance order interactions or “mock fights,” 4 occurred when a mare separated from her band was being retrieved, 1 was a “mock fight” between a harem stallion and male foal, and 1 was a complicated battle involving five harem stallions and two immature males.

In a study of feral horses inhabiting Shackleford Banks, Rubenstein and Hack (1992) observed natural occurring contests between 21 stallions during one breeding season. Of 310 male-male contests, 53 percent ended solely with an approach. In the remaining interactions, the stallions remained close to each other and displayed or fought. A portion of the close interactions became resolved with displays, but 58 percent proceeded to become physical. Of the contests that ended with displays alone, 79 percent concluded after sniffing or vocalizing.

Submission

Many instances of submission in horses occur without attracting much attention from an observer. For example, when a subordinate is approached by a dominant individual, the subordinate often seems to saunter away on its own initiative before the dominant is close. Thus, further interactions are avoided. Once the dominant individual moves away, the subordinate then returns to resume its previous drinking, foraging, or other activity. When a subordinate does not react as early to the approach of a dominant, its avoidance response will show deliberate, somewhat hasty withdrawal movements, especially when the dominant is within 2m; its ears are laid back as it steps out of the way. The common form of submission is to move away.

Upon yielding to a dominant or aggressor, young horses often move closer to their mother or peer companion, as if for comfort. When a foal returns to its mother after being threatened, it commonly initiates a bout of nursing (Tyler 1969; Blakeslee 1974).

Moving away from an aggressor is not always possible; yet submissiveness can still be shown. A horse that is trying to avoid an attack by a threatening individual close at hand will toss its head and neck upward and often to one side if the aggressor is in front, or, if the aggressor is behind, it will tuck its tail and flex the hindlegs while attempting to shift its rump away from the aggressor. In the head toss, the neck is raised maximally and the head is either tightly flexed or elevated close to or above horizontal. The eyelids open widely as the horse stares at the aggressor, exposing the light-colored scleral tissues around the iris. The nictitating membrane oftentimes covers the anterior portion of the eye as the head is elevated. The submissive or fearful head response occurs to rough human handling when the forequarters are abused, for example, with a whip, lead chain, or bit. The tightly tucked tail and crouching of the hindquarters occurs when a horse is hit along the back, rump, or hindlegs (Dark 1975).

Young horses three years of age or younger show a specialized form of submissiveness that has been called "snapping" (Tyler 1969), "teeth-clapping" (Feist 1971), "jaw-waving" (Blakeslee 1974), and "Unterlegenheitsgebärde" (Zeeb 1959b), and so on. An immature horse initiates the display by extending the head and opening the mouth, usually with the corners drawn back (Figure 19.5). The ears may splay laterally. The individual then begins a series of jaw motions, opening and partially closing the mouth without the lips (nor oftentimes the teeth) making contact. In some cases a slight sucking sound occurs with the jaw pattern as the tongue is drawn against the roof of the mouth (Schäfer 1975).

The snapping display of immature horses is given especially when the individual seems apprehensive about the proximity of a larger or more dominant animal. Tyler (1969) observed snapping in neonates when mares first turned to their foal after birth. Williams (1974) studied the displays in several orphan and mother-reared foals. One of the foals raised with its mother displayed snapping to an approaching cow when one week old. Some foals gave the display only to more mature horses; some responded upon the approach of humans. Machine-reared foals exhibited snapping to strange humans but not to familiar ones.

Most observers have noted that snapping decreases with age. Of the 252 instances reported by Tyler (1969), 58.3 percent were given by foals, 32.1 percent by yearlings, 5.2 percent by 2-year-olds, and 4.4 percent by 8-year-olds.



a.



b.



c.

Figure 19.5: Snapping display of submissive immature horses toward adult stallions. [Photos courtesy of R.R. Keiper (a,b) and P. Malkas (c)]

It appears that as youngsters gain more experience they learn to discriminate threatening from non-threatening situations. Subsequently, snapping tends to be limited to potentially threatening conspecifics when other agonistic responses are not prudent.

Foals and yearlings commonly display snapping when approached directly by adult mares and stallions. Foals searching for their mother often exhibit snapping as they approach each horse. Tyler (1969) noticed searching young foals even gave the display as they approached their own mother until they recognized her. Tyler also observed that young mares in their first estrus showed snapping when stallions sniffed, licked, or nibbled them as well as during copulation. When mares with foals are investigated by stallions, the foal commonly gives the jaw movement display; the mare rarely does.

In general, stallions induce more snapping displays than do other horses. Wells and Goldschmidt-Rothschild (1979) found, among yearlings and foals, males gave the display more often than females in the same age class. Snapping toward stallions seemed to be induced by mere proximity, but the display given to mares was more often in response to a direct threat from the mare.

Feist and McCullough (1976) noted several instances where snapping toward the dominant stallion was given by an immature male (a) immediately following an interaction between dominant stallions of different bands, (b) after mare tending by the stallion, and (c) after the dominant had been absent from the band for awhile.

Zeeb (1959b) suggested that snapping may have originated from social grooming and that the display of jaw movements could be intention movements. Feist and McCullough (1976) pointed out that grooming another individual can in some instances initially be an appeasement activity and that both snapping and appeasement grooming may be a ritualization which allows an immature to express subordination and perhaps avoid aggression. Aggression seldom occurs; yet because the immature horse does not necessarily withdraw and defuse the threatening circumstance, the situation remains tenuous until the mature horse accepts the gesture of submission. If the mature horse does not accept the closeness of the immature, it will show further aggression.

Abnormal Agonistic Behaviors

Flight responses in all their varying degrees, including balking, bolting, and shying are agonistic behaviors. They are normal responses when a horse is

fearful or startled; the individual usually tempers its response appropriately to the situation and mellows as it gains more life experiences. Yet, when fear responses are exhibited frequently or in excess to the situation, they are problem behaviors and are usually considered abnormal. When a horse shows an aberrant degree of balking, bolting, or shying, the underlying cause may be because of difficulties in perception or because of past fearful or unpleasant experiences. In the latter, a program of habituation may be required by the horse owner to desensitize the horse to fearful situations. Repeating fear-inducing stimuli frequently and especially with a gradual increase to full intensity will commonly cause the horse to adapt to the stimuli as it learns no harm ever follows.

Occasionally the amount and degree of aggression displayed by a horse can be out of the ordinary and require treatment. Appropriate therapy depends on properly identifying the specific type of aggression and its cause. Aggressiveness in horses can be categorized into the following types (Beaver 1986): fear-induced aggression, pain-induced aggression, intermale aggression, dominance aggression, protective aggression, maternal aggression, learned aggression, redirected aggression, play aggression, sex-related aggression, irritable aggression, hypertestosteronism in mares, genetic factors, brain dysfunction, and self-mutilation. The types that are commonly involved in aggressive behavior problems are briefly discussed below.

Fear-induced aggression (e.g., striking or kicking), like aberrant flight responses, can be reduced by gradually exposing the animal to relevant stimuli using a calm, firm, and persistent manner of handling. When the horse does well, the handler should communicate satisfaction by praising or rewarding the horse. The goal is to build the confidence and positive experiences of the animal, so fear becomes minimal and is kept under control.

When a horse is unable to withdraw from a painful stimulus, it will likely show pain-induced aggression (e.g., biting, kicking, striking). Problems usually arise because long-term memory of the bad experience is retained. Thus, when the horse is again in that environmental context, aggressiveness may recur even though the painful stimulus is absent. If the horse is unruly only under a specific context, then one solution may be to eliminate that situation and provide the horse only alternative contexts. If that is not possible, the horse must learn that pain will no longer occur under the previous context, for example, by repeatedly exposing the horse to that specific environmental context.

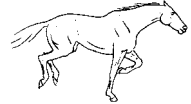
The tendency of a horse to fight other horses (e.g., intermale or dominance aggression) has been successfully treated in some male horses by castration or progestin treatment (Line et al. 1985; Beaver 1986). Thyroid replacement therapy helped in the case of a gelding treated by Aronson (1998). But such therapies do not necessarily work for all behavior problems involving fighting. Keeping the offending animal separated from other horses may be required. For reason of human safety and that of surrounding horses, maintaining reliable physical control over the offender is also important when handling or moving the horse.

Male-like aggressiveness has been found to be associated with elevated testosterone levels in mares (Cougouille-Gauffreteau et al. 1981; Beaver and Amoss 1982). If an ovarian tumor is involved in such hypertestosteronism, surgery is commonly the solution; but sometimes the cause of the hormonal disruption is difficult to determined or treated.

When a horse is known to be aggressive to humans, it is wise to maintain proper physical control over the animal. The reason for the aggression can be one of several. Sometimes such aggressiveness is due to the animal being in chronic pain (e.g., due to navicular disease or other ailment)—a case of irritable aggression. In redirected aggression, an agitated horse fails to direct its hostility to the actual cause and redirects its frustration toward handlers or companions. If dominance aggression is involved, initial aggressiveness by the horse should be met with immediate punishment. Quick timing and persistence are required by the handler. The horse thus learns its aggression is not appropriate and that it is not dominant to that handler. Conversely, sometimes horses learn to be aggressive to humans (learned aggression) because of the way humans treat them. For example, nipping often develops when horses have been handed sugar treats.

Horses that bite or rub their skin to the point of creating a skin lesion may be afflicted with neuritis, allergies, or irritants on the skin. Self-mutilation can also be the result of excessive restlessness or stressful situations. It is more common in stallions than in geldings or mares (Haupt and Kusunose 2000). Dodman et al. (1994) found evidence of heritability for the self-mutilation trait. Severe biting of the flank or chest can occur in extreme cases. Like other behavior problems, therapy needs to address the cause and factors that trigger a bout. Subsequently, an exercise routine, training program, physical restraint, or medical treatment may be in order (cf. Beaver 1986).

20 Communicative Behavior



Throughout much of each day, horses emit signals that convey information. The information may pertain to the horse's intentions, present activity, social status, mood and emotions, identity, physiological condition, or perhaps its awareness or concern about something in the surroundings. Often the horse itself may not be aware it is emitting such signals; yet, when another animal perceives and interprets any of the messages, information is exchanged and communication is achieved. The receiver may then emit signals relevant to the information it has just obtained and thus establish two-way communication. The information exchange is typically between horses; however, communication can also occur with other species, such as with humans. Communicative exchanges are fundamental to social interactions and group living among horses as well as to horse handling by humans.

Communicative signals between horses can be visual, acoustical, tactile, or chemical. Interactions often involve more than one mode. Gradations of many expressive patterns occur depending upon the degree of stimulation and the situation. The function attributed to the signals are usually inferences made from the environmental context and the reactions of the sender and recipient.

— Visual Expressions —

Various parts of the body are used in visual expressions; their effectiveness for communication may be as a whole (i.e., collectively), as subunits (e.g., head gestures only), or individually (e.g., only the mouth). Head and leg gestures are common and are accompanied by changes in the position of the ears, tail, and neck plus facial characteristics (Klingel 1972; Dark 1975; Schäfer 1975; 1978). The long hair of the forelock, mane, tail, and fetlock

accentuates visual displays. Visual displays range from exaggerated actions and patterns to subtle expressions (often overlooked by human observers). That horses can perceive and utilize even slight visual cues was clearly demonstrated in the oft cited case of Clever Hans whose intellectual skills were dependent upon being able to read the answers in the gestures of human bystanders (cf. Pfungst 1907).

Leg and Body Gestures

Stance and overall body posture, without requiring further details of facial features or movement, are useful signals to interpret such things as a horse's mood or physiological condition. The placement of the legs as well as the attitude of the head, neck, and tail provide a comprehensive signal. A horse in prolonged pain, for example, is usually recognized by overall body posture; the weight distribution on the legs may be noticeably shifted and a droopy appearance of the head, neck, and tail occurs.

Leg gestures are common signals in equine social interactions. For example, motions to strike with a foreleg or to kick with a hindfoot are common expressions in agonistic situations. A leg may be raised suddenly into a potential attack position and be held momentarily in threat. Oftentimes a kick or strike movement is made thrusting a leg or a pair of legs into the air; in most instances, the legs are either restrained or the aim indirect so as not to achieve contact with the stimulus object. The function of such leg gestures appears to be offensive or defensive warnings to cause withdrawal by the recipient and thus some spatial separation.

Knocking and stomping also occur in agonistic situations. The forceful contact of the legs with the ground adds an auditory component to the gesture. When an individual is eating and seems to object to being crowded by others, it may knock with a hindleg without ceasing its eating activity and, thus, efficiently signal its protest. Ödberg (1973) reported a mare knocked repeatedly with a hindfoot when crowded at a brush pile while eating. In a similar manner, a gelding consuming oats in a field threatened away approaching calves. Ödberg's conclusion was that such knocking stems from an intention movement of a kick.

When a horse with ears laid back aggressively thumps the ground with either a fore- or hindfoot while being prepared for a ride, the gesture seems to signal the horse's objection or protest. Knocking as well as hindleg lift can be frequent when insects and other irritation occur at the belly and flanks; occasionally the hindleg is used to bump the abdomen under these

circumstances. These gestures can serve as warnings to a foal or veterinarian causing irritation.

Pawing often serves as a visual signal. The movements can vary from slight to exaggerated and can be accentuated by the sound of contacting the substrate. Ödberg (1973) noted that pawing (as a possible displacement activity) occurs in conflict situations, such as (i) when a horse is aware of food but is unable to reach it, (ii) sometimes during eating while in the presence of onlookers, (iii) when anticipating locomotion, such as a race or release from restraint, and (iv) occasionally by stallions who are delayed while being led to a mare for breeding. Maday (1912) pointed out that pawing often serves to signal a want or need. Pawing can function to scrape, uncover, or test something and, at the same time, so inform others; it often occurs prior to rolling, during investigation of objects on the ground, and to dig for food or water. Occasionally pawing-like motions signal discomfort, such as during parturition and when the mare struggles to discharge the fetal membranes. Pawing can become conditioned as seen in some begging horses as well as in performing horses (such as circus horses) where reinforcement has strengthened the behavior.

Additional leg movements can have signal value. The alternate lifting of the forelegs occurs in restlessness and may become established as the habit called weaving. The treading in place or marking time occasionally shown by standing horses while being restrained by a rider seems to express the horses desire to move forward. To the rider the movement is more a tactile expression, but to an onlooker it is a visual display. In highly schooled horses, this behavior pattern is developed as a piaffe executed in place.

Locomotor activity can be expressive. For example, brief bouts of trotting using audible hoof contact with the ground and shifts in direction of travel are characteristic of a nervous horse investigating a suspicious object. As the individual withdraws suddenly in alarm, companion horses commonly react to the sudden flight and likewise withdraw. Conversely, slow locomotion in a relaxed manner signals that there is no alarm, that calm prevails.

Other visual cues, such as facial and tail gestures, accompany locomotor activity and undoubtedly clarify most situations. This becomes obvious when observing the approach of a stallion to a potentially receptive mare. The high neck, tightly flexed head, attentive focus of the ears, and elevated tail nearly overshadow the springy prance used by the stallion in locomotion.

Vertical head motions in the form of nodding often occur during approach situations. Stallions oftentimes nod as they approach a mare. Foals nod on some occasions when eagerly approaching their mother.

The lateral motion of the head and neck during weaving is an overt visual display. Since weaving develops as a stereotyped pattern primarily under confinement, the value of the display as a visual signal between horses may be nil. Yet to a person familiar with horse behavior, weaving can be a signal that all is not well with the housing or other management conditions.

Facial Expressions

Facial expressions vary primarily by changes in the orientation of the ears and eyes; changes in the position of the lips, jaw, and eyelids; changes in shape of the nostrils; and contour changes of the skin surface, especially at the corners of the mouth as well as around the eyes and nostrils. Some features are situation specific; for example, nostril dilation is generally associated with deep breathing and sniffing. Lack of tonus in facial musculature upon death (Figure 20.1) produces an expressionless appearance in contrast to the various displays occurring while alive.

To review the multitudinous head and facial features of potential value in visual communication, it is helpful to group the expressions into sets of related expressions. The scheme my students and I have adopted includes expressions of drowsiness and sleep, forward attention, lateral attention, backward attention, alarm, aggression, sensual pleasure, snapping, flehmen, and yawn (Dark 1975; Waring and Dark 1978). Expressions used in the flehmen response and while yawning have been discussed in Chapter 3 and will not be repeated here. The paper by McDonnell and Haviland (1995) provides further details.

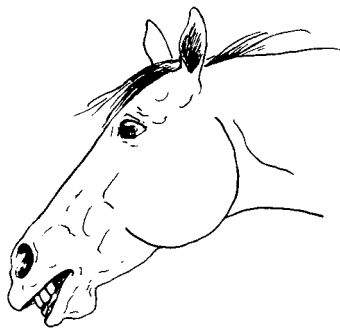


Figure 20.1: Facial characteristics of a dead horse for comparison to expressive displays of living horses. (Dark 1975)

Facial expressions of drowsiness and sleep vary primarily in the amount of eye closure and droop of the lower lip (Figure 20.2). When a horse goes from alert wakefulness to drowsiness, the slight eye closure and relaxed body posture help signal the change. The ears continue to rotate toward surrounding sounds, but other movement is rare.

As sleep progresses, the neck continues to relax and approaches horizontal. The ears relax to a lateral position and cease movement. The eyes close. And in some horses, the lower lip droops noticeably, separating and extending beyond the upper lip. The horse is often standing or in sternal recumbency. In lateral recumbency, eye closure and complete relaxation is typical. Slow-wave sleep may progress to a bout of paradoxical sleep where twitching and movement of legs and facial features occur. As one horse becomes drowsy and sleeps, other members of its social unit appear induced through social facilitation to also relax and sleep.

Expressions of forward attention are characterized by anteriorly directed orientation for reception of visual, auditory, olfactory, and sometimes tactile cues (Figure 20.3). The ears are up and rotated forward. The eyes are directed forward and appear to emphasize the binocular visual field. The neck and head angle adjusts to facilitate use of the sensory receptors. An elevated neck with head flexion is used for distant visual inspections.

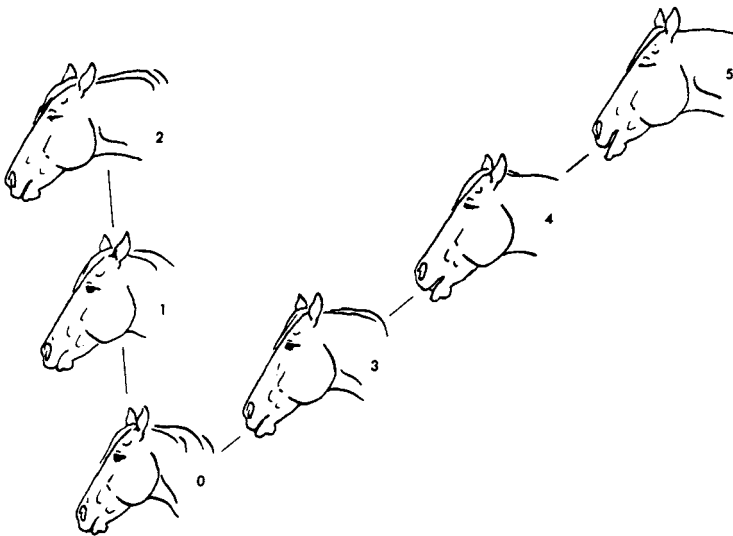


Figure 20.2: Expressions of drowsiness and sleep. In some horses, the lower lip droops as sleep progresses, such as 0-3-4-5. (Waring and Dark 1978)



Figure 20.3: Expressions of forward attention. (Waring and Dark 1978)

0 and 0-5	Horse standing or moving in alert manner.
0-1-2-3-4	Investigation or manipulation of material on or near the ground.
4-3-2-1-0	Ceasing of feeding to observe something in the surroundings.
0-5-6-1 and 0-1	Inspection, such as naso-nasal greeting or when handed food.
0-5-6-7	Sexually aroused stallion or horse activated while on a halter line.
0-8-9-10 and 0-8-11-12	Displayed during energetic locomotion (tail often elevated).
8-9-10	Horse actively avoiding an object on or near the ground; horse yielding to bit pressure.
0-8-11-12	Horse approaching a jump.

Head and neck extension occur in close olfactory and tactile investigations. The nostrils are moderately dilated especially when sniffing. The mouth is usually closed.

Expressions of lateral attention are characterized by general relaxation, with the eyes and usually the ears oriented to the side (Figure 20.4). Sensory receptors, if not attentive to something along one side, may not be focused on anything in particular. Often the horse appears to have no immediate concerns. The individual may be inactive or in motion; horses relaxed while being ridden or routinely handled may also show these expressions.

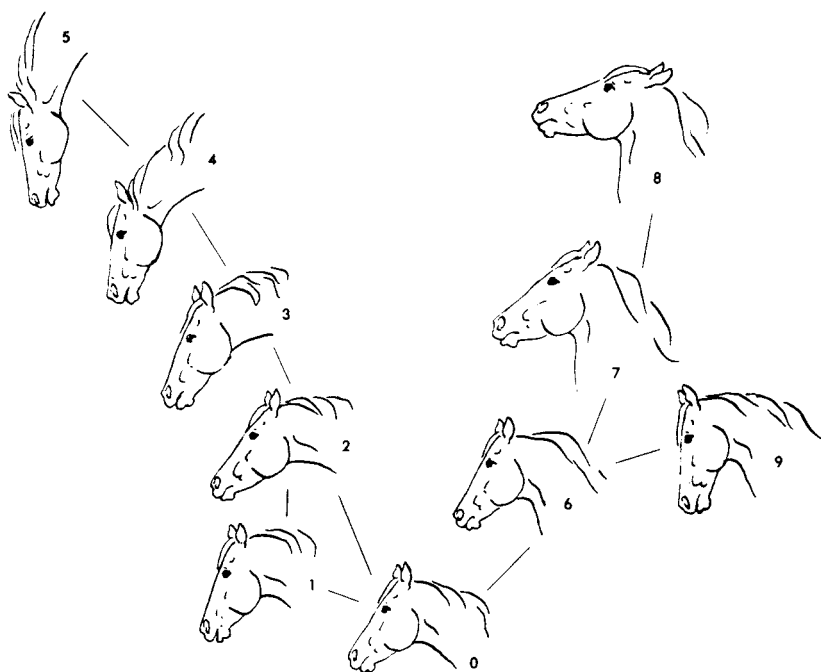


Figure 20.4: Expressions of lateral attention. (Waring and Dark 1978)

- | | |
|-----------|---|
| 0-1-2-1 | Horse in relaxed walk; pattern occurs also when shaking. |
| 0-2-3-4-5 | Lowering of head during quiescent grazing; reverse sequence occurs during pauses. |
| 0-6-7-8 | Play fighting, often while facing opponent and achieving head and neck contact. |
| 0-6-9 | Tractable horse at ease with rider. |

Expressions of backward attention are characterized by the eyes and usually the ears being rotated to enhance posterior perception (Figure 20.5). The mouth is normally closed unless the horse is vocalizing or has a bit or other object in its mouth. The expressions occur not only with posterior visual and auditory investigation while the head is directed anteriorly, but also the expressions may occur when a horse is stressed, uncomfortable, or seems apprehensive about the rider.

Expressions of alarm show as widely opened eyes, twitching ears, tense mouth, and dilated nostrils (Figure 20.6). Tension throughout the body occurs and is often accompanied by sudden jerky withdrawal movements, cringing, sweating, as well as increased respiration and heart rate. Gradations vary from alert suspicion to extreme fright.

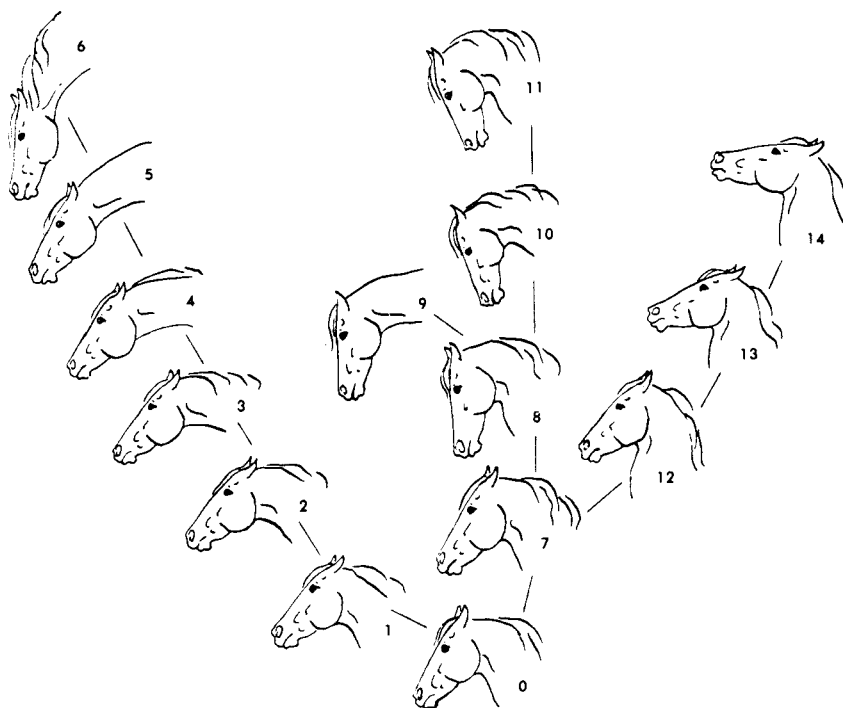


Figure 20.5: Expressions of backward attention. (Waring and Dark 1978)

- | | |
|---------------|--|
| 6-5-4-3-2-1-0 | Sequence shown by a grazing horse that is approached from behind.
Reverse sequence occurs with continued vigilance as grazing progresses. |
| 0-1-2-3 | Horse pushing against a restrictive barrier. |
| 3-4-5 | Horse physically exhausted or in discomfort. |
| 4-5 | Facing downwind during a severe storm. |
| 0-7-8-9 | Tugging at bit and reins to succeed in release of rein tension from rider. |
| 8-10-11 | Occurs during strong tension on reins when tack limits head elevation. |
| 0-7-12-13-14 | Variations during head tossing, balking, or bolting—often in response to harsh handling by rider. |

In expressions of aggression, the ears are laid back and compressed against the skull (Figure 20.7). The eyes are alert, open, and generally oriented toward the object causing the aggression. The nostrils are usually dilated and drawn back with wrinkles occurring along the upper, posterior edge. General muscle tension of the body is evident, and the mouth may be open. In extreme cases, the incisors may be exposed conspicuously to bite or to threaten biting. When exhibiting a bite, bite threat, or the snaking display the neck is lowered and the head extended. Aggressive expressions vary in intensity and occur in aggressive conflicts between horses and nearby animals.

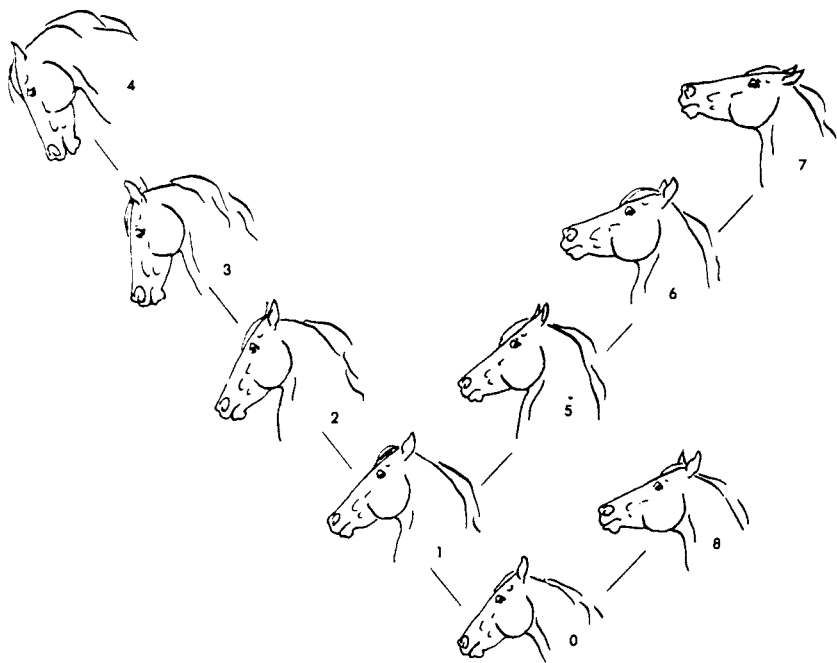


Figure 20.6: Expressions of alarm. (Waring and Dark 1978)

- | | |
|-----------|---|
| 0-1-2-3 | Frightened horse in locomotion. |
| 0-1-2-3-4 | Horse being subjected to roughness by rider when restrictive equipment suppresses head extension and elevation. |
| 0-1-5-6-7 | Alarming stimulus beside or below horse. |
| 0-8 | Horse approached by suspicious object. |

When a horse (either by itself or with the help of others) is rubbed, scratched, or groomed it oftentimes exhibits behavioral evidence that intense pleasure is occurring. The expressions of sensual pleasure are characterized by the extension and action of the upper lip (Figure 20.8). The eyes orient laterally and may close slightly; usually the ears are up. As the tactile sensations continue the upper lip extends more and more and twitches rapidly. If the upper lip contacts something, the object is rubbed using the quivering lip. The nostrils do not dilate but shake in conjunction with the active upper lip. The head extends somewhat and may turn to one side. Heavy breathing, groans, and leaning toward the stimulation may also occur.



Figure 20.7: Expressions of aggression. (Waring and Dark 1978)

0-1-2-3-4	Expression during biting and bite threats.
0-1-2-3-5	Horse driving or dispersing others—often while swinging head in snake-like manner.
0-6-7-8-9	Vigorous approach of stallion toward another male.
0-6-10-14	Pattern shown during aggression with rider, during bucking, and in male-male fighting.
0-10-11	Expression during kicking and kick threats.
0-10-11-12-13	Displays occurring with foreleg striking, rearing, pushing, and avoidance; also occurs when handler strikes head of horse with quirt or whip.

In the expression of snapping, the head extends, the mouth opens slightly, and the corners of the mouth are drawn back (Figure 20.9). Vertical jaw movements occur, causing a series of chewing-like movements. Mouth closure is usually incomplete during the bouts of jaw movement. Clicking of the teeth or sucking sounds occasionally occur. The lips remain separated; in some cases, only the lower incisors remain visible. Young horses display this gesture toward adults when apprehensive about the approach or possible reaction of the nearby horse. The display can also occur as a similar response to the nearness of a human, cow, or other large organism.

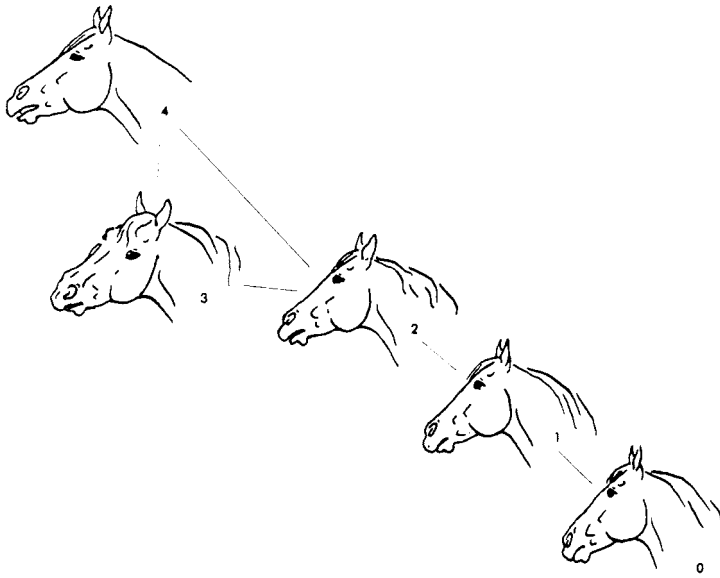


Figure 20.8: Expressions of sensual pleasure. The upper lip extends and twitches. On some occasions, the head may turn. (Waring and Dark 1978)

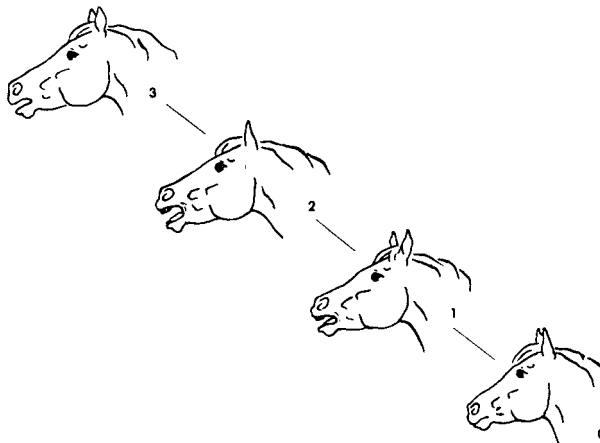


Figure 20.9: Expression of submission shown by horse giving the snapping (Unterlegenheitsgebärde) display. (Waring and Dark 1978)

The ears vary in position but tend to spread laterally; the eyes usually orient toward the stimulus source. Submissiveness appears to be expressed.

Tail and Other Gestures

Tail displays (Figure 20.10) commonly accompany facial, neck, and leg expressive movements. Furthermore, the tail can independently have signal value, such as in the display of estrus, where often the tail is erected and held to one side. A relaxed horse carries its tail down. The tail is compressed against the hindquarters when a horse is facing downwind during a severe storm, in extreme submission, or when withdrawing with intense fear or alarm. As locomotor movements increase in speed and stride, the tail elevates correspondingly to the level of the back or higher, usually with a slight arch. Under exuberant and animated locomotion, the fleshy portion of the tail often reaches vertical; the long hairs of the tail stream behind in a showy display. Kiley-Worthington (1976) concluded that the tail is raised as an intention movement to move faster and lowered as an intention movement to decelerate.

During aggression, the fleshy portion of the tail appears to stiffen, thus the tail displays posteriorly even with slight elevation. Flying insects are brushed off the hindquarters using tail switching from side to side. Forceful sideward motions of the tail, occasionally with vertical lashing, are commonly shown when a horse is annoyed, such as preparatory to kicking, striking, bucking, and balking. During copulation, the stallion's tail is elevated and rhythmically flexed in the vertical plane during ejaculation. Prior to defecation the tail is elevated. In the mare, the tail is raised and held to one side during urination and copulation. When a stallion is marking using bursts of urine, his tail is elevated more than during normal urination.

Although head, locomotor, and tail displays are used as expressions of sexual interest or activity, there are additional visual sexual signals that need mention. Frequent winking of the vulva by the mare in estrus repeatedly exposes non-pigmented membranes as the clitoris is everted. In conjunction with the elevated tail display, winking may help signal to stallions the mare's level of receptivity. In like manner, the erection of the stallion's penis helps signal sexual readiness of the male.

Besides leg and tail movements, additional visual patterns that occur in response to insect pests and skin irritation are shaking and skin twitching. When irritation is around the face, ears, or neck, head shaking occurs intermittently.



Figure 20.10: Tail postures and displays. (Waring and Dark 1978)

0	Relaxed position while standing.
1-2-3-4-5	Variations progressing from leisure walk to faster gaits, including jumping while at ease.
0-1-2-6	Sequence prior to defecation.
1-2-6-7	Display typical of mare in estrus as well as during urination and copulation.
1-2-6-8-9	Tail switching at insects and prior to kicking, striking, bucking, and balking. Some lashing in the vertical plane may occur in aggressive displays.
1-2-6-10-11-12	Display during intense exuberance or excitement, usually accompanied by snorting or blowing and energetic trotting or galloping.
2-6-10-11	Tail display of stallion during mounting and copulation.
0-13-14-15	Display of aggression, alarm, or when horse is not at ease with a handler.
0-16-17	Display of extreme fear or submission, prolonged pain, or while facing downwind in severe weather.

Localized twitching of the skin surface occurs, especially with irritation around the shoulders and forelegs. Shaking of the whole body occurs commonly after rolling and, for example, after a saddle is removed. Whether such visible displays are communicative to other horses is not known.

Acoustical Expressions

A variety of sounds are produced by horses. Voiced emissions using the larynx include squeals, nickers, whinnies, and groans. Non-voiced sounds include snorts, blows, snores, hoof-substrate sounds, mouth smacking, and incidental sounds from tail switching, eating, grooming, shaking, snapping, coughing, flattus, and male sheath movements. Communicative use is made of voiced sounds and of at least some of the non-voiced emissions. For illustration, I will use sound spectrograms not previously used in Waring et al. (1975) or Klingel (1977).

Squeal

Squeals are high-pitched outcries that show distinct spectrographic appearance of having harmonic quality; the fundamental frequency is usually close to 1 kHz (Figure 20.11a,b). Although higher frequencies are present, most of the sound energy occurs below 4 kHz. In some horses, these sounds seem more harsh than those of others. Squeals are given as single utterances in agonistic situations, apparently as a defensive warning or threat that the annoyed individual will become more reactive if further provoked. Squeals are typical during aggressive interactions between horses (e.g., between stallions), during sexual encounters when the mare protests the stallion's advances, and when a pre- or early-lactating mare objects to being touched anywhere near her obviously sore mammary glands. The duration of squeals varies considerably, ranging from less than 0.1 second to over 1.7 seconds (Table 20.1). Mild protests are the shortest.

As a squeal begins, the mouth is closed, but as the sound continues the corners of the mouth may begin to retract. Mouth opening is not typical but may occur (cf. Kiley 1972; Stevenson 1975). Head extension or flexion as well as lateral head movements may accompany the sound. Depending upon the situation, loudness varies from weak squeaks audible only up to a few meters away to loud screams audible at a hundred meters or more. A mare's protest of a nursing attempt by her neonate is normally less audible than the same mare's squeal response to a teasing stallion.

Table 20.1: Duration of Sounds Emitted by Horses

	n	Range (msec)	Arithmetic Mean (msec)	Geometric Mean (msec)	Standard Deviation
Squeal	34 (7)*	80–1,720	870	760	340
Nicker	110 (8)	250–1,720	870	780	370
Whinny	56 (13)	500–3,180	1,500	1,140	530
Groan	22 (4)	60–1,690	450	340	380
Blow					
Alarm	20 (6)	210–1,190	470	420	270
Exhalation after sniffing	12 (6)	650–1,330	910	890	210
Snort	25 (5)	280–1,680	900	810	410
Snore					
Pre-blow inhalation	7 (3)	340–460	390	390	50
Dyspnea inhalation	5 (1)	1,040–1,750	1,380	1,350	270

*Number of horses (American Saddlebreds) providing sample.

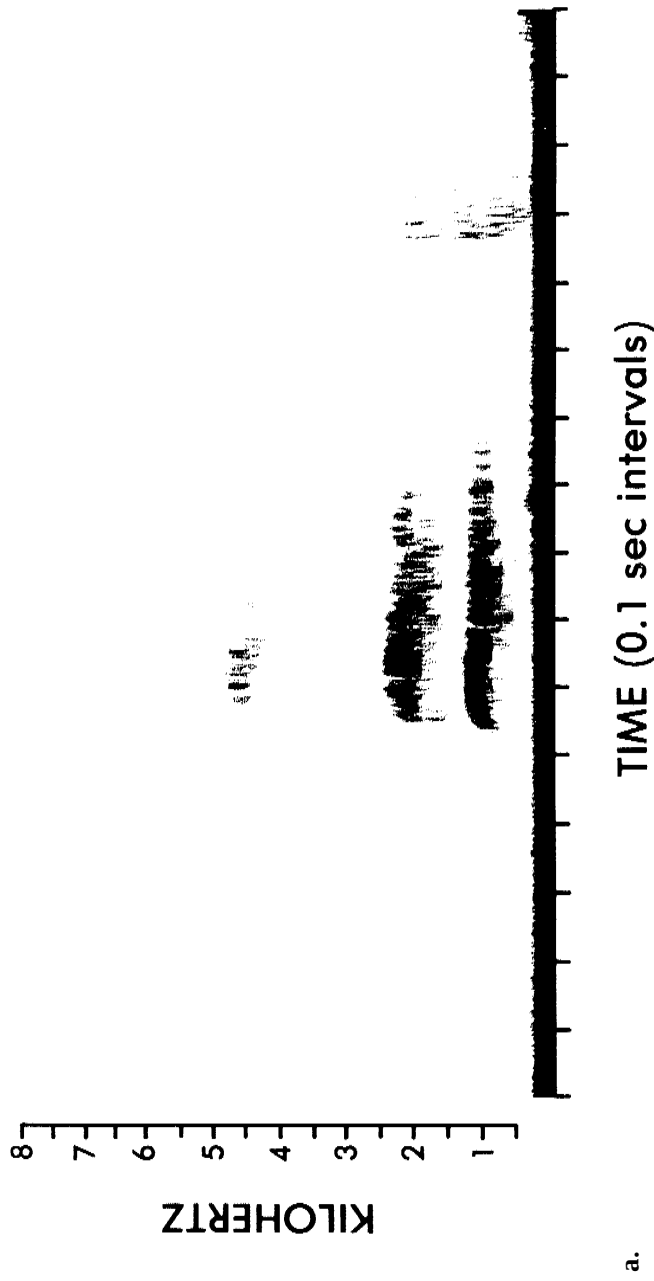
Data from Waring 1971

It is likely that squeals have characteristics unique to each individual and that horses may interpret something about the vocalizer, e.g., as a familiar individual or as a stranger. Using playbacks under field conditions, Rubenstein and Hack (1992) concluded stallions were more likely to approach the squeal of a low-ranking male but showed little interest in squeals of stallions they had never encountered and those they encountered on a regular basis. In their study, subordinate stallions seemed to have shorter and thinner-sounding squeals.

Nicker

Three types of nickers have been distinguished. Each are low-pitched, broad-band vocalizations with a guttural pulsated quality audible to an observer. Resonance bands commonly appear on sound spectrograms. For most nickers, sound energy is typically below 2 kHz; the duration of the nickers I analyzed ranged from 0.2 to 1.7 seconds (Table 20.1).

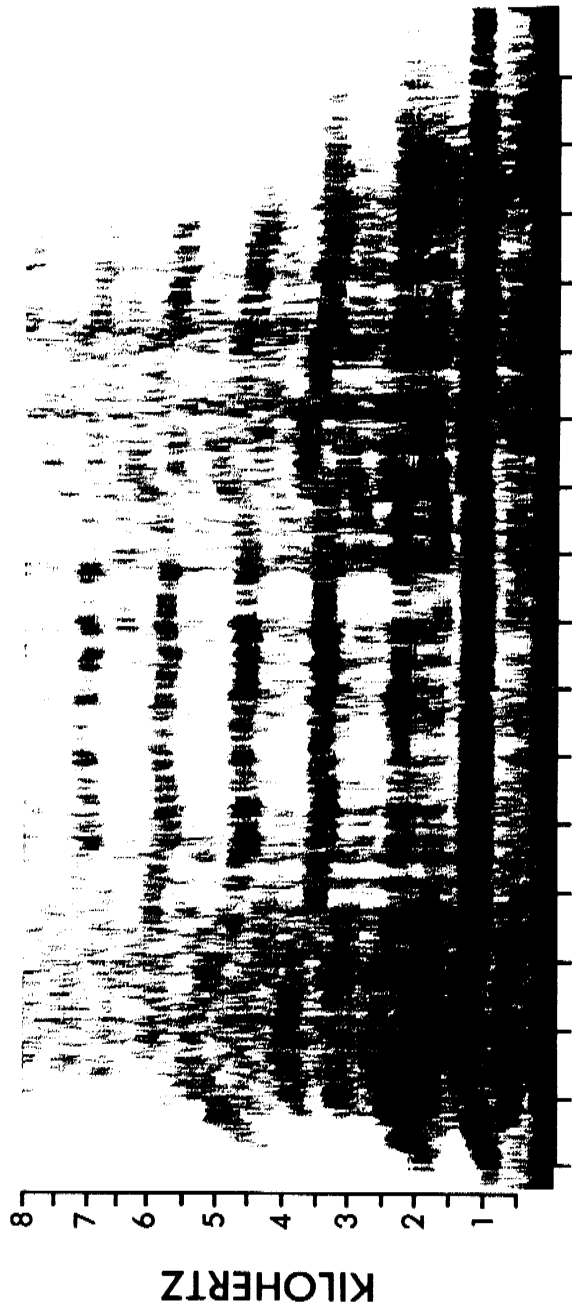
The nicker commonly heard by horse handlers occurs most often just prior to being fed, i.e., while begging (Figure 20.11c). This type of nicker, whether to a human or another horse, announces the horse's presence and anticipation.



a.

Figure 20.11: Sound spectrograms of common horse sounds: (a,b) squeal, (c) nicker (horse awaiting food), (d) nicker (stallion courting), (e) nicker (mare to foal), (f,g) whinny, (h) groan, (i) blow (alarm), (j) blow (after sniffing), (k) snort, and (l) snore (dyspnea). Analyzing filter bandwidth was 300 Hz. (Waring 1971)

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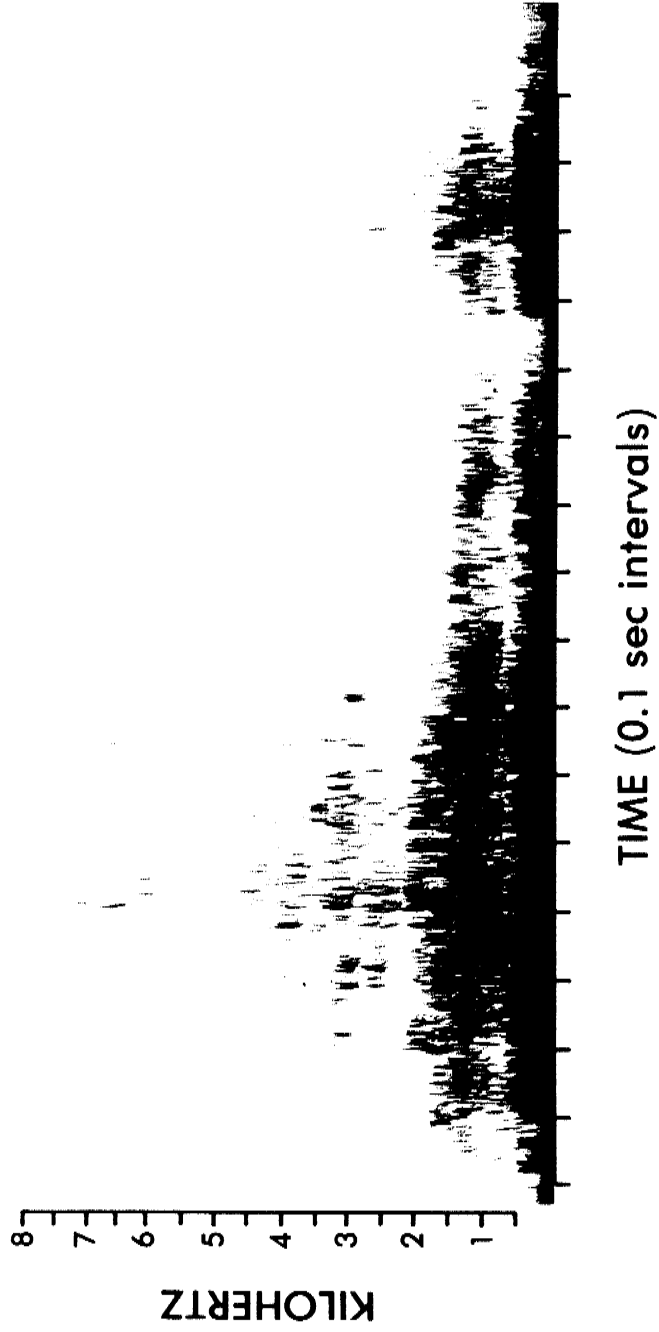


b.

TIME (0.1 sec intervals)

Figure 20.11: (cont.) (b) squeal.

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c.

Figure 20.11: (cont.) (c) nicker (horse awaiting food).

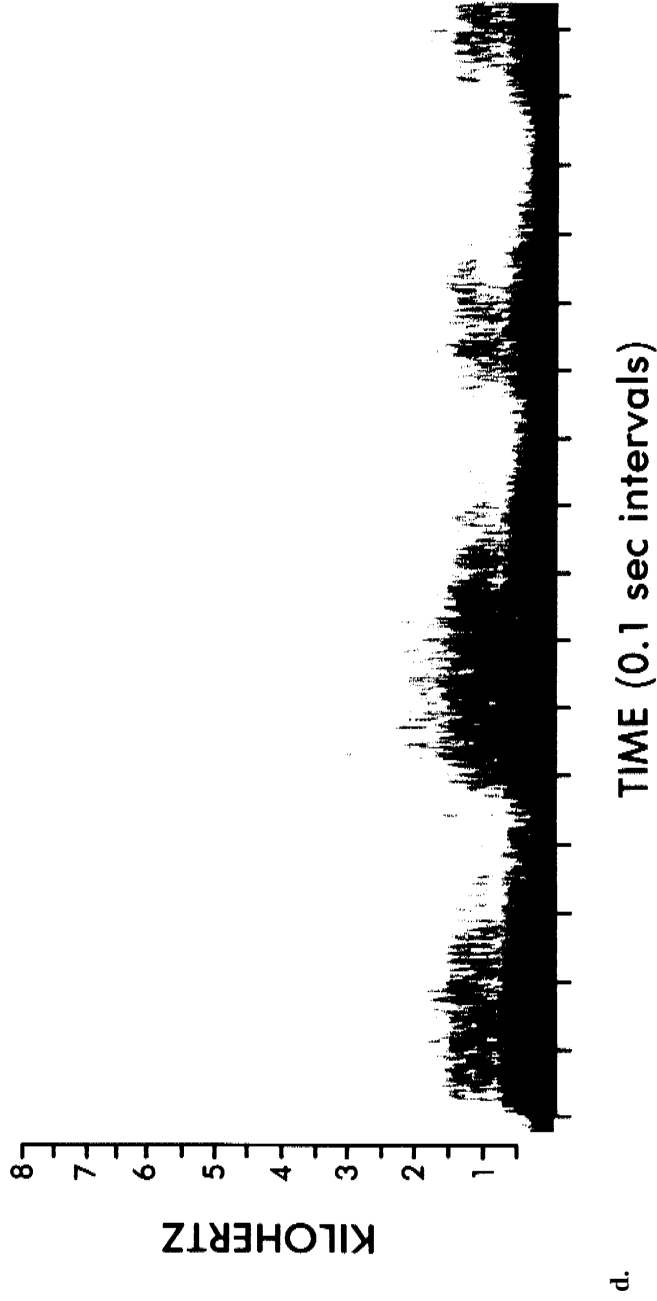


Figure 20.11: (cont.) (d) nicker (stallion courting).

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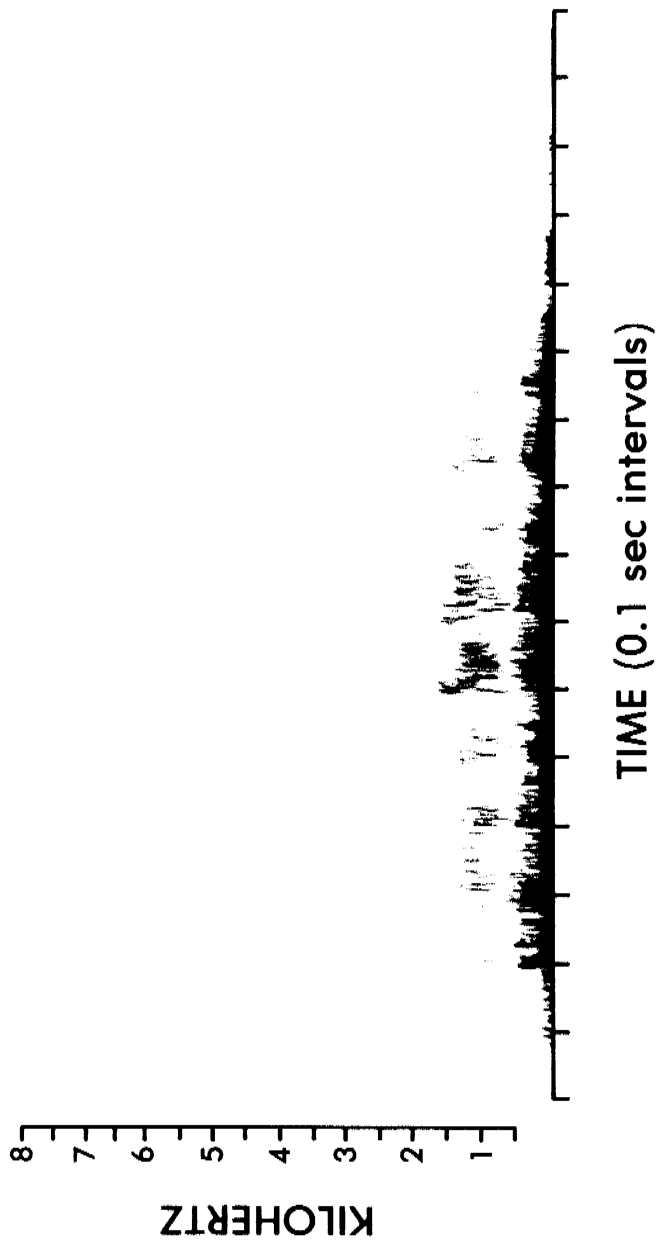


Figure 20.11: (cont.) (e) nicker (mare to foal).

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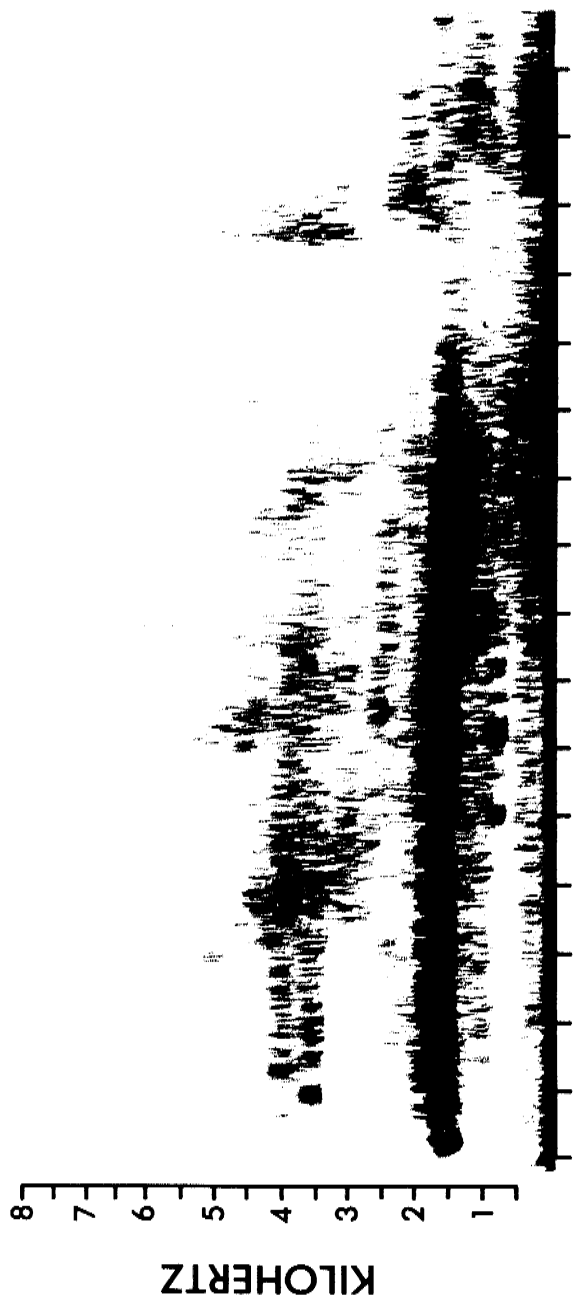


f.

TIME (0.1 sec intervals)

Figure 20.11: (cont.) (f) whinny.

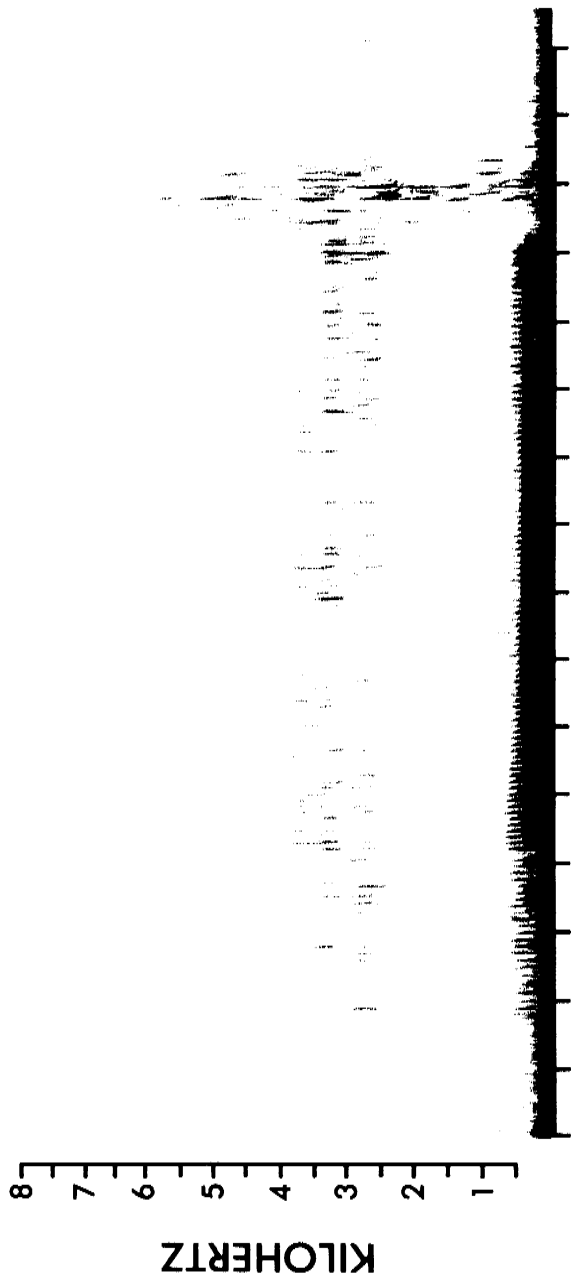
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TIME (0.1 sec intervals)

Figure 20.11: (cont.) (g) whinny.

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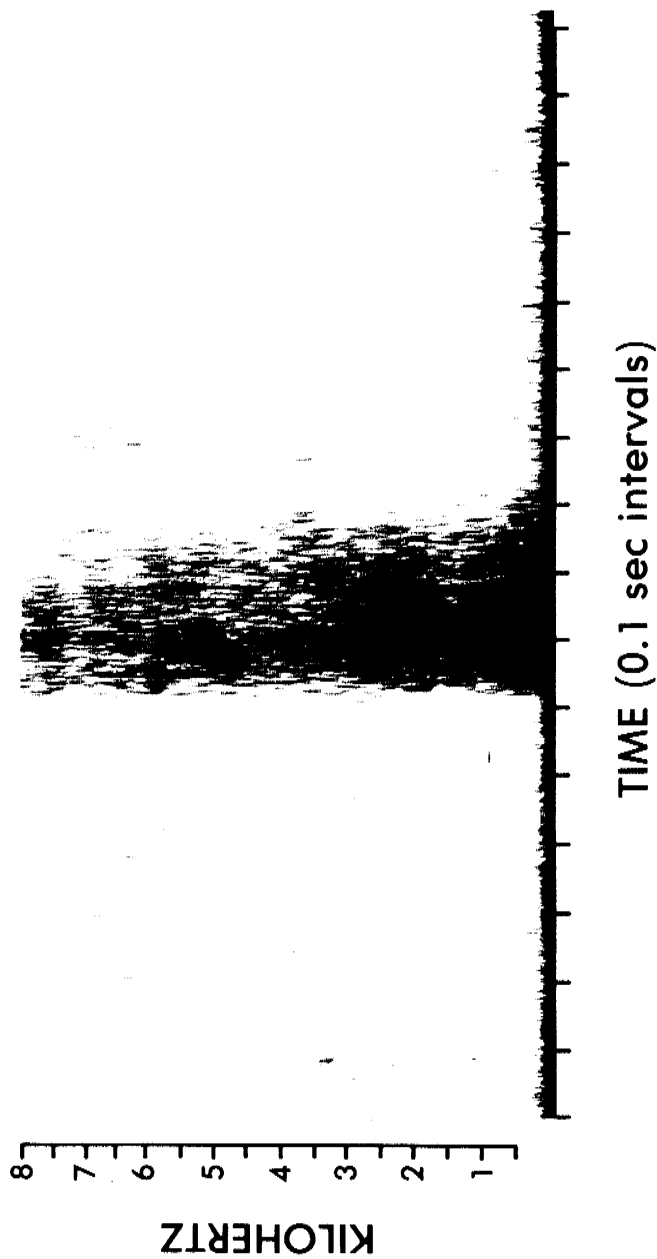


h.

TIME (0.1 sec intervals)

Figure 20.11: (cont.) (h) groan.

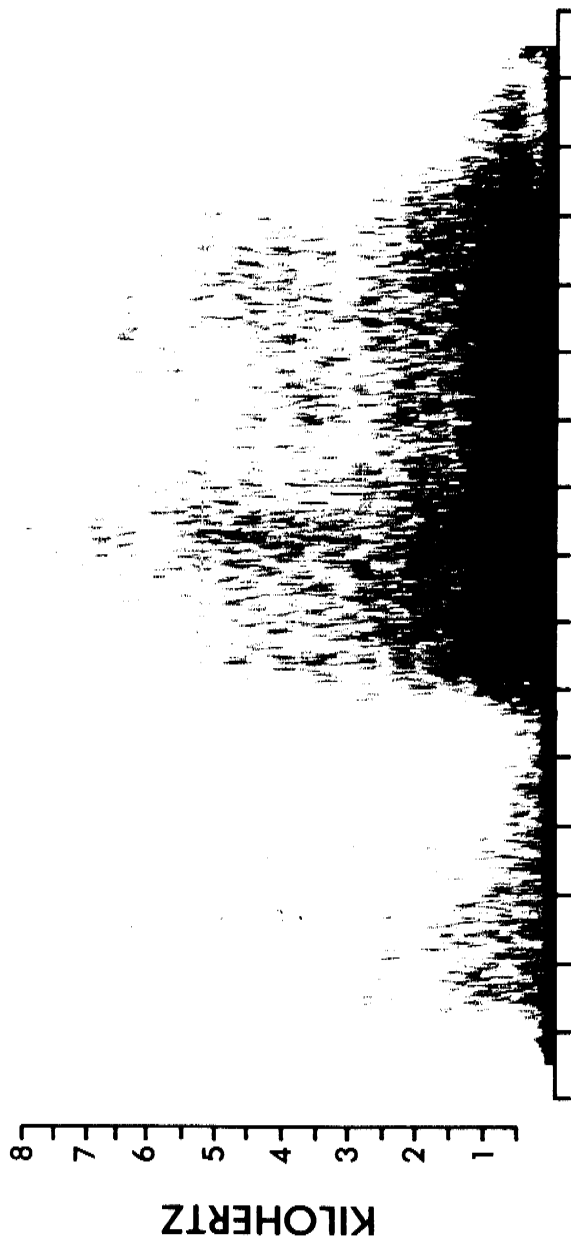
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i.

Figure 20.11: (cont.) (i) blow (alarm).

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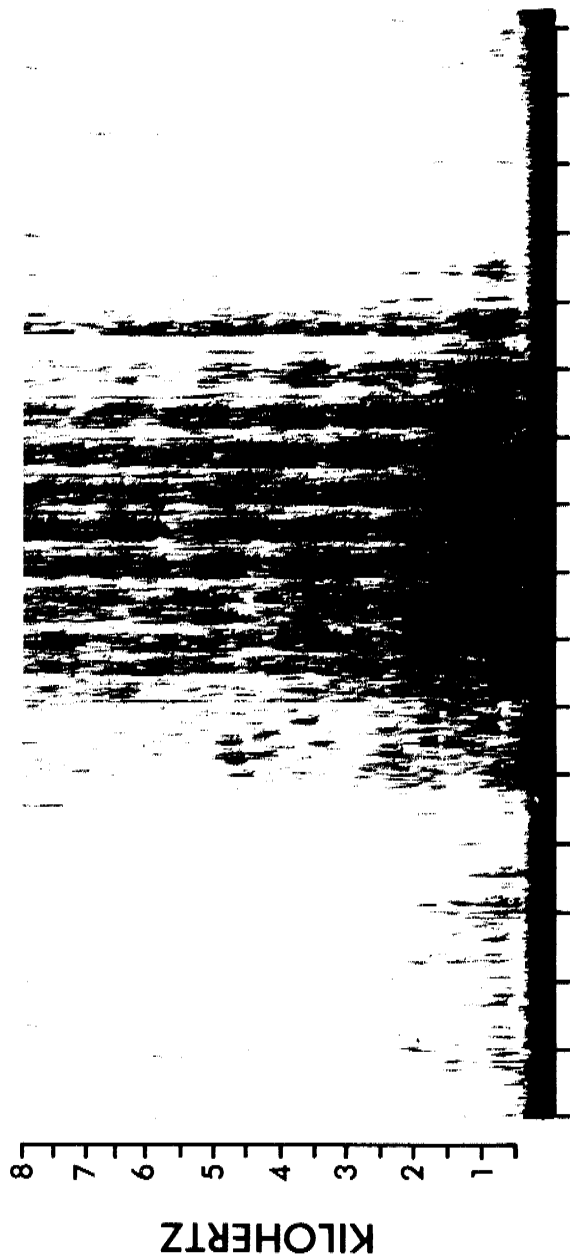


j.

TIME (0.1 sec intervals)

Figure 20.11: (cont.) (j) blow (after sniffing).

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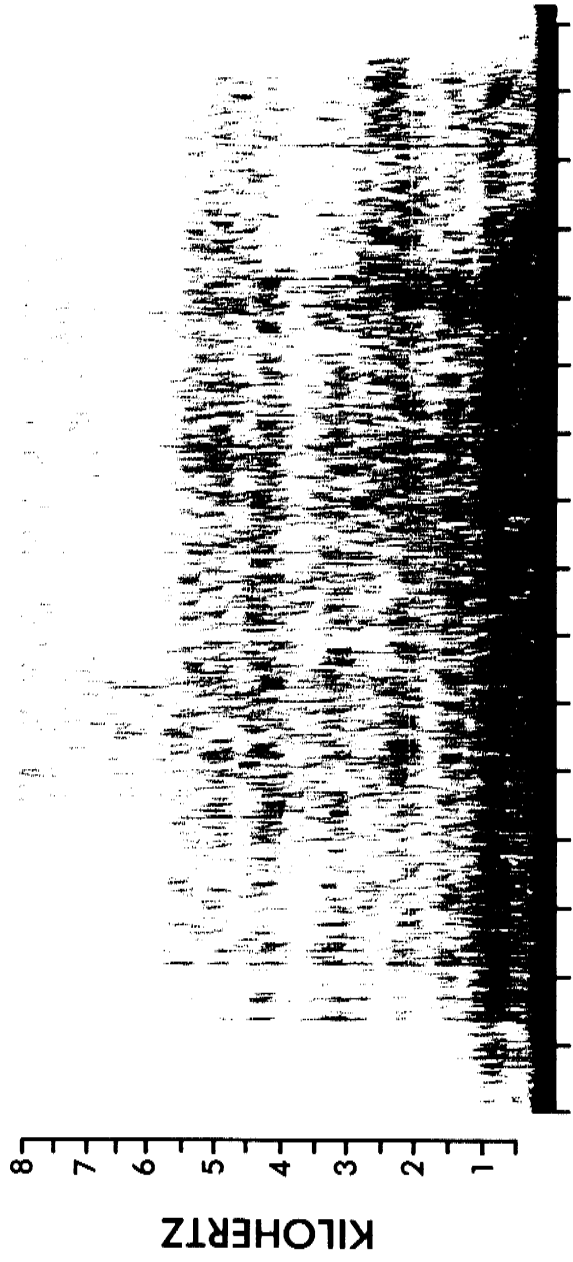


k.

TIME (0.1 sec intervals)

Figure 20.11: (cont.) (k) snort.

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1.

TIME (0.1 sec intervals)

Figure 20.11: (cont.) (1) snore (dyspnea).

Easily audible at 30m, this type of nicker appears least broken into syllables (both to the human ear and on sound spectrograms) than the other two types of nickers. Stevenson (1975) noted the muzzle was raised about 2 cm during the anticipatory nicker, the nostrils were relaxed, the mouth remained closed, and often ear movements occurred.

The second type of nicker (Figure 20.11d) is emitted by stallions during sexual behavior, especially while being led toward a potentially receptive mare. The sounds appear to signal the stallion's sexual interest and are audible at 30m or more. Repetitious broad-band notes are given, with each stallion having his own individual characteristics (such as in pulsation rate). Repeated head nodding may occur as the stallion maintains a generally collected appearance with head flexed and neck elevated. During the sound, the mouth remains closed and the nostrils are well open.

The third type of nicker (Figure 20.11e) is typically given by mares to their young foal when potential danger appears or the mare is otherwise concerned about the foal. The low-pitched vocalization, given with mouth closed, expresses the mare's concern and induces the foal to move closer to her side. When isolated from the mother, I found neonates could be induced to more readily follow a human if these nickers were imitated and often repeated. A multi-beat, repetitious quality of the mother-foal nicker is typical, e.g., with loudness reaching a peak every 0.1–0.15 second during the duration of the call. Nevertheless, the level of loudness is so low the sound is usually not noticeable beyond the immediate vicinity of the mare and her foal.

Whinny (Neigh)

Whinnies are vocalizations that appear to begin as squeal-like emissions with harmonic structure visible on sound spectrograms and terminate as broad-band patterns similar to nickers (Figure 20.11f,g). Pitch is initially high and appears to drop when the lower-frequency nicker-like portion begins. Whinnies are the longest and most audible of horse sounds, lasting an average of 1.5 seconds (Table 20.1), and often detectable at a distance of 1 km.

Stevenson (1975) noted horses often commenced eye blinking and a head turn just before momentarily elevating the muzzle and emitting a whinny. The nostrils dilated slightly, and at first the mouth was closed. By the time the nicker-like phase of the whinny began, the mouth was open, the corners of the mouth were drawn back, yet the teeth remained covered by the lips. Some walking movements often occurred.

During a whinny, the ears and eyes usually exhibit forward attention (cf. Trumler 1959; Schäfer 1975). As the sound ends, the mouth closes and the head returns to a normal position. Oftentimes, the ears then move back and forward alternately. The nostrils remain somewhat dilated until the horse further relaxes.

Individual recognition may prove to be one of the additional functions of whinnies, nickers, squeals, and possibly other horse sounds. Wolski et al. (1980) found mares tended to whinny more often to playbacks of whinnies of their own foal than to alien foal whinnies, but the difference was not statistically significant (sign test, $P > 0.05$). Munaretto (1980) in a similar test found a mare responded vocally to her own foal's vocalization significantly more often than she responded to that of an alien foal ($\chi^2 = 19.44$, $df = 1$, $P = 0.05$); reciprocally, the foal demonstrated some ability to differentiate between the real and alien mare sounds, but the difference was not significant. Tyler (1972) observed instances where foals responded vocally only to their own mother's whinnies and where band members only replied to the whinnies of lost members of the same band. Because of a foal's direct orientation and return to its mother upon her nicker, Tyler concluded that by the time foals reach 2 to 3 weeks of age they can identify their own mother's nicker. Further study on individual acoustical recognition is warranted.

When horses become separated, such as a mare and foal or peer companions, one or both individuals often whinny to maintain or to regain contact. At other times, whinnies occur when horses seem inquisitive after seeing a horse in the distance or when they become curious about certain familiar sounds occurring out of view. Whinnies, therefore, seem to facilitate social contact while at a distance. Under playback situations, both whinnies and nickers elicit more attentive responses from test horses than do squeals (Dixon 1967; Ödberg 1969).

Groan

Groans are monotone vocalizations that to the human ear appear non-pulsated. Yet these hum-like sounds under 300 Hz bandwidth analysis can show very rapid pulsation as well as a resonance band on sound spectrograms (Figure 20.11h). The voiced groan may be followed immediately by a broad-band, non-voiced but audible completion of the same exhalation. The duration of groans varies from approximately 0.1 second to 1.7 seconds (Table 20.1). Short-duration groans are sometimes called grunts.

The vocal emission seems to be an expression of mental conflict, suffering, or physical effort. For example, often groans occur during prolonged

discomfort (such as a mare with a retained placenta) and is given from a lateral recumbency position. A single sigh-like groan commonly occurs as a weary horse achieves recumbency. Combatants may give grunt-like sounds during interactions. Some stabled individuals seem to use the groan while standing relaxed, as if bored with nothing to do. Most groans are audible only within a few meters of the source.

Blow

The non-pulsated, broad-band sound produced by forceful expulsion of air through the nostrils is called a blow (Figure 20.11i,j). Although some frequencies of these non-voiced sounds extend above 8 kHz, most of the sound energy is below 3 kHz. Blows are most audible within 30 m. When emitted as an expression of alarm (e.g., while hesitantly investigating a suspicious object several meters away), the average duration is less than 0.5 second (Table 20.1). Such brief and forceful blows apparently serve to alert nearby horses and inform the intruder it has been detected. Stevenson (1975) noted that nostrils dilate completely during the brief blow, the mouth remains closed, and lack of movement during and immediately after the sound is typical. More prolonged blows (range 0.6–1.3 seconds) are emitted during olfactory investigation when the individual exhales after a bout of sniffing.

Snort

Snorts are also broad-band sounds of forceful exhalation through the nostrils but are characterized by an audible flutter pulsation (Figure 20.11k). The nostrils can be seen to flutter with each pulsation and the mouth remains closed. The average duration of a snort is 0.8–0.9 second, and loudness is normally sufficient to hear the sound at 50m. Horses emit snorts when the nasal passage is irritated (such as with dust), sometimes immediately after vigorous locomotion, or when the individual is restless and yet constrained, such as by a human handler or barrier. Under the latter conflict situations, snorts appear to be a displacement activity and seem to express the horse's restlessness. A snort-like exhalation with rapid flutter also occasionally occurs with labored breathing.

Snore

Snores are broad-band, raspy inhalation sounds (Figure 20.11l). These non-voiced sounds seem incidental to inhalation especially under two circumstances. One is prior to emitting an alarm blow, where the preceding inhalation occasionally is a brief audible snore lasting 0.3–0.5 second. If such

a sound functions in communication, it probably serves as a preparatory or sensitizing cue for the subsequent alarm blow. The second situation is with labored breathing of a recumbent horse, when the inhalation may sound like a human snore lasting 1.0 to 1.8 seconds (Table 20.1).

Other Sounds

Hoofbeats may have a function in equine communication. The sounds can indicate the presence and location of individuals plus the type of locomotion being used. The accentuated hoofbeats of a horse circuitously investigating a suspicious object appear to gain the attention of other horses.

Occasionally a mare will give an audible smack with mouth movement as a mild threat to a nursing foal whose head is deep within her flank. Smacking appears to be a variation of a bite threat and has been noted when the mare turns her head toward the nursing foal and opens her mouth suddenly creating the sound (Crowell-Davis 1985).

Incidental sounds of eating, tail switching, coughing, grooming, snapping, shaking, and so on possibly convey information to neighboring horses about ongoing activity. Specialization of these sounds for communication is not apparent.

Tactile Interactions

When two horses interact at close range, tactile exchanges often occur. Upon initial greeting during naso-nasal interaction, some direct touching may occur as well as the indirect tactile effects of forceful exhalation. One or both individuals may then make contact at the flank or genital region of the other. The importance of such tactile activity is not clear.

Mare-foal interactions often involve tactile activity. Mothers nudge their foal periodically with their muzzle to direct the foal's movements. Nuzzling with the upper lip also occurs, apparently to offer reassurance. A prolonged bout of licking by the mare occurs soon after parturition but rarely occurs thereafter. Foals nibble and lick their mothers, especially in the first day; nudging and sucking at the teats occur during nursing. The foal's nuzzling at the flank and ventral surface of the mare seems to signal care solicitation.

Foals sometimes induce their mother to interact with them in a bout of mutual grooming by first nibbling at the mare. Allogrooming in older horses is normally initiated by one individual gently nibbling at the neck or withers of another.

Aggression often involves tactile interactions. Biting, pushing, striking, and kicking are tactile signs of aggressiveness. The intensity of the signals reflects the seriousness of the interaction. In mock fighting, the approach, sequence of events, intervening activities, and level of intensity apparently cue opponents that the interaction is playful (i.e., they serve as metacommunication cues).

Tactile cues are also exchanged between horse and human handler. A rider can interpret much about a horse's coordination, tractability, attentiveness, and understanding of commands by utilizing tactile signals transferred, for example, via the reins and the rider's legs. Numerous tactile signals are likewise given to the horse by the rider; only a portion may be intentional commands. Various pieces of horse apparatus, such as bits and spurs, are often designed and used for tactile effect.

Chemical Exchanges

Olfactory cues seem to be sought by horses as they approach and investigate each other during their rather ritualized greeting interaction. Sniffing is obvious at the initial naso-nasal and head phase; it often is continued at the flank and genital region. Excrement and novel objects are typically investigated extensively using smell. Flehmen sometimes occurs. How much information a horse gains from olfactory investigation is not known; however some discrimination between individuals apparently occurs, as evidenced by marking behavior of stallions and the ability of mares to distinguish their own foal using olfaction. When Wolski et al. (1980) modified olfactory cues between mare and foal, the individuals had difficulty finding their appropriate partner. Marinier et al. (1988) found stallions, responding to odor cues, appeared to discriminate between some mares. Rubenstein and Hack (1992) found feral stallions were much more likely to investigate the dung of unfamiliar stallions than samples of familiar stallions.

Stallions appear to be initially attracted to mares in estrus primarily by visual, rather than olfactory, cues. Once in contact with a mare, the stallion may proceed with olfactory investigation and with testing the receptivity of the mare. If the mare does not object, most stallions continue to show sexual interest, especially toward adult mares, without additional evidence of olfactory investigation. When the mare shows slight signs of objection, the stallion may smell the mare's vulva and urine. Flehmen may follow (as if to further test the situation), and in some cases loss of libido occurs. Wierzbowski (1959) found adult stallions with experimentally impaired

olfaction showed no inhibition of sexual behavior. Inexperienced stallions, however, showed more need for odor cues; for example, young stallions showed sexual interest in a dummy if it was first sprinkled with urine of an estrous mare. Experience, therefore, seems to play a role in how extensively and when a stallion uses odor cues.

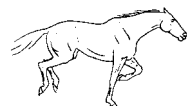
Excrement, saliva, breath odor, secretions, and numerous glandular areas (Schaffer 1940) on the skin of horses provide possible sources of olfactory cues. Further study will be necessary to better understand chemical communication in horses.

Part VI



Ecological Influences

21 Interaction of Horses and Their Environment



The behavior patterns exhibited by horses are influenced by their environment; moreover, the environment is influenced by the activities of the horses. These interactions will be considered sequentially in this chapter as home range preferences and habitat utilization, bioenergetic considerations, the influence of resource distribution on territoriality, environmental influences on activity patterns and movements, strategies against pests and predators, symbiotic relationships, and finally the influence of horses on their environment. Ecological influences on such factors as parturition, development, dispersal, social structure, reproductive success, and population dynamics are covered in Chapter 22.

Home Range Preferences and Habitat Utilization

Feral horses inhabit a variety of habitats, from sandy barrier islands to high altitude grasslands. They prefer relative level terrain and tend to avoid steep slopes (Ganskopp and Vavra 1987, Negi et al. 1993). In some locations they inhabit forests and in other locations they are in landscapes devoid of trees. In many locations, feral horse populations are on range that has not been in heavy demand by humans or their agricultural needs; oftentimes in these locations food and water resources are limited. Thus horses demonstrate they are adaptable and can survive in sparse environments; yet, within the habitats available to them, they select and utilize (sometime seasonally) specific areas. Such sites usually provide the most efficient foraging opportunities with access to drinking water plus relatively comfortable conditions.

Habitat selection and use by feral horses on the Red Desert in southwestern Wyoming was studied by Miller (1983a) utilizing daylight aerial surveys at four week intervals between November 1977 and April 1979. Horses were

found in sagebrush-grass habitat (56 percent of the study area) especially during the fall and winter; in late spring and early summer, the horses especially utilized saltbush-winterfat areas. Except during winter, the horses tended to be within 4.8 km of a water source (59 percent of the study area). During winter they tended to be within 1.6 km of ridges (66 percent of study area).

In hilly to mountain ridge habitat east of Owyhee Reservoir in Oregon, feral horses were monitored for two years by Ganskopp and Vavra (1986). Year-round sources of forage and water were widely distributed over the area. Various grasses and shrub overstory of sagebrush characterized the major plant communities. The initial horse population was 133 and increased by 13 percent annually. Six distinct geographically-spaced herds were identified, with a total of 21 harem bands. Home ranges of various harem bands and bachelors often overlapped or were nearly superimposed. Home ranges averaged 12 km² with the minimum polygon procedure and 27 km² with the 90 percent confidence ellipse method. No seasonal shifts in home ranges occurred nor were correlations detected between home range size and number of horses per band, densities of perennial water sources, or levels of forage production within home ranges. Only one band shifted location to another herd. Animals in each herd made greatest use of the most prevalent plant community available; no plant community was universally preferred over another. Only the shrub scabland community (of steep, southfacing slopes) was universally avoided; in this habitat, little herbaceous production was evident.

On the Rhône Delta of southern France, the Camargue horses studied by Duncan (1983; 1992b) preferred areas with the greatest concentrations of green plant matter, while available. For the most part, all individuals used the whole 335 hectare study area which was stratified into 8 landscape classification units—the extremes being marshes (colonized by reeds) plus course grasslands at the top of the catena. When green plant matter became sparse at the end of winter, the horses searched out areas with the greatest concentrations of perennial herbaceous plants (green or dead).

In the Granite Range of northwestern Nevada, Berger (1986) observed feral horses tended to have summer home ranges above 2000m and winter, spring, and fall ranges at lower elevations (approximately 1500m). The low-altitude home ranges were smaller than the high-altitude areas. The animals gradually shifted about 8 km between seasonal sites using steep slopes and ridgelines. Besides seeking high-quality forage, a major factor in the change of range, Berger concluded, was to minimize discomfort. With the onset of intense winter storms, horses sought shelter in ravines and juniper forests; during summer, when insect pests increased, the horses fed in meadows

early in the day then sought adjacent snow patches or windy ridgelines for relief from the pests as the day progressed.

Bioenergetic Considerations

Energy is regularly exchanged between the animal and its environment. When horses have free choice, they commonly position themselves within their environment where they are most comfortable. Often this comfort has to do with thermoregulation. For example, during the hottest period of a summer day they may seek shade to reduce exposure to infra-red thermal radiation. Or early on a cool sunny morning, they may position their body broadside to the direct rays of the sun to gain maximum solar warming. Or under blustery winter conditions they may seek shelter in a ravine or among trees or shrubs to reduce loss of body heat (cf. Berger 1986).

Horses spend energy in a variety of ways, including body maintenance, thermoregulation, locomotion, harem defense, reproduction, parental care, and so on. Energy demand varies with the circumstance. Vigorous activities (e.g., gallop) expend more energy than less vigorous forms (e.g., walk). And the demand for high energy expenditures often comes at intervals. For example, during the last trimester of pregnancy, the fetus grows rapidly and puts a high energy demand on the mother. Lactation also places a high energy demand on the mare. Seasonally stallions incur high energy expenditures associated with harem defense.

As changes in the rate, intensity, and type of behavior occur, energy expenditure can change. The behavior patterns exhibited by horses are often those that make efficient use of the body's resources and the horse's ability to sustain the activity. In part, an accelerating horse shifts from one gait to another at a point when the new gait is more efficient regarding energy and speed. Energy conservation is not always the sole issue. For example, horses were observed to switch from a trot to a gallop at a speed that was 13 percent higher in energetic cost than for trotting (Farley and Taylor 1991). Heglund et al. (1974) found both stride frequency and stride length increased with increasing speed; however, within a gallop, speed was increased primarily by increasing stride, whereas frequency remained nearly constant. Because of the nearly constant stride frequency in the gallop, Heglund and his co-workers concluded the transition from trot to gallop occurred at the maximum sustained stride frequency of the animal.

Energy expenditures must be offset by energy intake through foraging. When energy demand is high for a given animal, it often feeds more; when that is not possible, the individual loses weight and condition.

Commonly horses show efficient ways to replenish their nutritional and energy resources. To this end, they select specific food items, feeding locations, and feeding times.

—Influence of Resource Distribution on Territoriality—

Under most open-range situations, horses share food and water resources with other horses. Most individuals live in social groups (bands); the remainder are solitary. Normally the home range of a band or individual overlaps partially or completely with other horses. Territoriality in horses typically is not one of maintaining a defended territory but is instead one of defending the social unit or personal space from encroachment by outsiders.

Nevertheless, for a narrow barrier island off the North Carolina coast, Rubenstein (1981) reported some feral horses of Shackleford Banks maintained defended territories. Their unusual trait was correlated with the unique habitat and geographical features of the island. The fact that the horses inhabited an island was not the reason for such territorial behavior, since defended territories have not been evident during studies on other islands (e.g., see Welsh 1975; Keiper 1976a).

On Shackleford Banks, only some harem stallions maintained territories. Rubenstein (1981) noted that the territories included the width of the island and only occurred where (i) the island was narrow, (ii) the visibility was unrestricted, and (iii) essential vegetation ran along the island's long axis. At such sites, the difficulties of defending the site were minimal whereas opportunities were excellent for mate guarding and feeding. At other locations, for example, where sand dunes were high and forest dense, horses were non-territorial. At the unique sites claimed as territories, food and water were adequate for the entire band and not essential for other horses, intruders could approach only from the two land boundaries, distances were relatively short, and visual monitoring of the entire site was easy.

—Activity Patterns and Movements—

Environmental Influences on Time-Budgets

Depending on the season and environmental conditions, horses proportion time spent on daily activities in different ways. For example, they may spend more time feeding and less time resting. In part, their time-budgets are

situation specific. Physiological needs and energy conservation may be involved, as might comfort and other factors. Duncan (1980) found Camargue horses spent less time in recumbency during colder months and more time in the standing posture; recumbency was especially high in spring (Duncan 1985). During summer months horses often seek retreats where harassment by biting insects is reduced (Keiper and Berger 1982). Other horses may stand side-by-side facing opposite directions and mutually use tail switching to discourage biting insects from landing on the forequarters of their neighbor. Devoting time to such behaviors rarely occurs in other seasons. To offset time not eating, horses often compensate by feeding at night when tabanid flies are not as troublesome.

Social factors and available resources also can influence time-budgets. Comparing horses housed in groups to those housed alone, Kiley-Worthington (1984) found solitary individuals spent less time eating and more time standing as well as sleeping than group-living horses. When roughage is fed, horses spend more time eating than when prepared diets are fed and roughage is limited.

Diurnal and Nocturnal Movements

Horses roam their home range, especially for food, water, and shelter. Movements can occur during daylight as well as at night. The feral horses observed by Berger (1986) traveled further during daylight hours (mean = 1.32 km) than at night (mean = 0.45 km). Although annual differences occurred in daily movements, nighttime travel varied little. Throughout the year and each season, both day and night travel by bachelors were greater than by harem stallions. Bachelors older than 9 years traveled further than younger males lacking female companions. On days when parturition occurred, multiparous females and their bands covered twice the distance (mean = 1.59 km) than did animals from bands containing primiparous females (mean = 0.78 km). On cold, stormy days horses moved little.

Seasonal Movement Patterns

On open range, horses often utilize their habitat similar to a rotation grazing system, where they shift sites within their annual home range yet forage each site at approximately the same time each year (e.g., Miller 1983b). Each environment has its unique features that change during the year. The horses sequentially utilize different portions of their range as sites with the highest-quality foods become available (cf. Duncan 1983) or as conditions warrant use of those sites.

In the Granite Range of northwestern Nevada, most of the bands observed by Berger (1986) moved from low- to high-altitude home ranges in late spring or early summer. The response appeared to coincide with newly emergent vegetation, increasing temperature, and flying insects. Prior to migration to summer range, some bachelors and harem bands conducted forays to and up the mountain slopes. Clumping of bands near the slopes occurred a few days or weeks before migration to elevations above 2000m. Fall migration to lower altitudes often did not occur until after the first snowfall. Snow cover appeared to be the major inducement for fall migration.

Antipredator Strategies and the Use of Sanctuaries

Predation pressure on horses is relatively low in most areas of the world today; however, predators such as wolves, pumas, and bears pose a problem in some regions (cf. Turner and Morrison 2001). Young are most at risk. Watchfulness, avoidance, and flight are the means horses usually employ to avoid contact with predators. Group living is beneficial for mutual vigilance and protection (cf. Berger and Rudman 1985). The alert posture, emission of the blow sound, and audible hoof beats seemingly inform companions (as well as the intruder) that danger has been detected. The distance between individuals in a social group decreases when danger is imminent. If withdrawal occurs (e.g., flight), the group usually acts in unison. Stallions typically show protectiveness of their band, and mares show protectiveness of young. Older, experienced mares seem to be more protective of neonates during the first 20 days compared to younger mothers (Cameron et al. 2000). Protectiveness can be threats as well as overt aggression. The precocial developmental status of newborn foals is effective as an antipredator strategy; it permits a foal to stand and be mobile at its mother's side soon after birth.

During summer months, horses often experience harassment from biting insects, especially tabanid flies. When the harassment reaches a threshold level, horses often move to a site in their range where harassment is reduced. This may be a thicket, snow patch, water retreat, ridgeline, hill-top, or other effective refuge (e.g., Duncan and Cowtan 1980; Keiper and Berger 1982). Some retreats place the horse more or less physically out of reach of the pests. But other sites capitalize on the tendency of flying pests to avoid windy conditions. Microhabitats that have greater wind velocity help reduce fly harassment (cf. Hughes et al. 1981). Besides using such sanctuaries, horses often cluster when harassed by biting insects and

experience less harassment (cf. Rutberg 1987); two or more horses often mutually assist each other using tail switching

Under stormy and especially wintery conditions, horses also seek refuge. The horses studied by Berger (1986) specifically sought clumps of juniper when weather was severe. They also were observed to retreat to ravines or slopes.

— Symbiotic Relationships —

Intermittent symbiotic relationships between birds and large animals, such as ungulates, are well known. In such relationships, the birds either seek ectoparasites or obtain insects disturbed by, as well as attracted to, the large animals. By eating ticks and biting insects or by scaring away pests, the birds benefit their symbiotic partners. With horses, such a symbiotic relationship occurs primarily with cattle egrets (*Bubulcus ibis*) (Figure 21.1); however, other birds may be involved. During horse-egret interactions, the birds feed most often while on the ground; yet, sometimes they feed while perched on a horse's back. Horses allow the activities of the birds and are not aggressive toward them. The overt passiveness of horses to the physical contact and intimate activities of the birds is evidence that the horses may receive some comfort from the relationship and control their agonistic responses accordingly.

Keiper (1976b) in a study of the relationship between cattle egrets and feral ponies found the greatest feeding activity of the birds occurred when the egrets were on the ground within one meter of the ponies. Feeding strikes were not just directed at insects on vegetation. These birds directed 29.1 percent of their feeding strikes at insects on the ventral regions of the ponies, as follows: foreleg 10.5 percent, hindleg 10.2 percent, and underside of the body 8.4 percent. As many as seven egrets were seen feeding simultaneously on and near a single pony. The birds were found to be associated with stallions, mares, as well as foals in all kinds of weather and were seen to take tabanid horseflies. Not only grazing ponies attracted feeding egrets, but also ponies walking, standing, lying down, as well as nursing.

On some occasions, Keiper noted, the egrets joined the ponies while they were on sandy beaches far from vegetation, apparently to feed on insects associated with the bodies of the ponies. Egrets were often seen perched on the backs of ponies, staying up to 50 minutes at a time. Resting and preening were the common activities while perched. When egrets did feed while perched on top of ponies, feeding strikes were directed around the head of the pony (37.9 percent), the sides (35.1 percent), the back (18.9 percent), and the forelegs (8.1 percent).



Figure 21.1: In some regions, a mutualistic relationship develops between horses and cattle egrets. The birds benefit by feeding on insects disturbed by or attracted to horses, and the horses benefit by the removal of horseflies and other pests on their body. (Photo courtesy of P. Malkas)

Beside mutualistic relationships with other animal species, horses host a number of internal and external parasites. In most cases, the behavioral responses horses give to such parasites are reactions to irritations the pest may cause plus escape and avoidance maneuvers. Some insects (e.g., tabanids) seem especially vexing to horses. A horse's response can include rubbing, scratching, skin twitching, tail switching, shaking, rolling, and even refuge seeking. Behavioral responses to endoparasites are not so obvious (cf. Rubenstein and Hohmann 1989).

One parasitic relationship needs special mention here—namely, the foraging vampire bat (Subfamily *Desmodontinae*). In tropical and subtropical regions where these sanguinivorous mammals exist, vampire bats often feed on horses. Their technique is to locate a site on the horse where they

can pierce the skin and initiate blood flow, then ingest the blood. Typically the horse reacts little to the bat's activities, seemingly because there is little discomfort and the foraging location is often along the midline of the back, out of reach to the horse.

■ Influence of Horses on Their Environment ■

There are numerous environmental factors that influence horses (as noted above), but consider for a moment the impact horses have on their environment. Certainly horses affect the plants they utilize for forage; yet, grasses and many other plants are rather well adapted to feeding by herbivores, and some utilize ungulates for seed dispersal. When horses are in open-range conditions with species such as deer, moose, elk, and cattle, spatial separation of the ungulate species is evident and small overlap occurs in their dietary selection (e.g., see Salter and Hudson 1979). Competition for forage is more likely to occur as plant diversity and habitat is reduced. Arnold (1984a) studied the spatial relationship between sheep, cattle, and horses grazing together. Each species widely utilized the ample pastureland provided, maintained a degree of spatial separation from the others, and harmoniously co-existed with the other species. Only when feed supplements were provided were the horses considered dominant among the three herbivores under study.

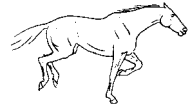
Native herbivores typically influence the character of the habitat, including the diversity, density, and productivity of the plant community. The interactions that occur in ecosystems often affect many of the abiotic and biotic components. Depending on one's point of view, the resultant changes can be considered as enhancing or degrading. When exotic species are present, such as domestic horses and cattle, they too can have an environmental effect and are themselves affected. Moderate levels of resource use by exotics can enhance populations of other species. For example, in the Great Basin of the western United States, exotics have seemingly influenced the landscape in a way that has enhanced mule deer populations (Berger 1986). And Coates and Schemnitz (1994) reported male mountain sheep may benefit from close foraging relationships with feral horses.

In the Camargue of southern France, horses have been successfully utilized in the management of wetlands for waterbirds (Duncan 1992b). Between the years of intense study (1975–1983), the increasing population of horses consumed an estimated 3 to 20 percent of the annual net aerial primary production of the range. The impact of the horses was much stronger on the wetland vegetation of the region than on the dryland. In both

areas, monocotyledons were the preferred foods. In grasslands, plant height and cover declined under grazing, while diversity increased; several perennial species declined, yet annuals increased. In the marshes, horse grazing greatly reduced *Phragmites* and measurably decreased *Scirpus*; annuals increased. The overall result of horse foraging was a reduction of the standing crop of the herbaceous plants and the creation and maintenance of open habitats, especially in the marshes. The habitat thus became attractive to waterfowl, such as coot and dabbling ducks.

Duncan (1992b) concluded that without grazing by such large herbivores, the Camargue study area would eventually be covered by three main vegetation types fully dominated by one or two perennials—marshes (*Phragmites* and *Scirpus maritimus*), salt flats (*Arthrocnemum* sp.), and high ground (*Phillyrea angustifolia*). Thus, he pointed out, horses provide managers of grazing lands (including wetlands) a powerful tool and an alternative to herbicides, mechanical cutting, and fire.

22 Ecological Influences on Reproduction and Social Behavior



Many aspects of reproduction and social life are influenced by environmental factors. Some are obvious; others are subtle. There are, for example, environmental influences over pregnancy, parturition, development, sexual maturity, dispersal, social structure and stability, reproductive success, and population dynamics. These topics, covered in this chapter, have been the focus of several recent investigations.

Factors Influencing Parturition

The majority of mares give birth to their foals in the spring, although some births occur throughout the year. Initially parturition is linked to the estrus, ovulation, and successful mating that occurred approximately 11 months earlier. Neuroendocrine responses are involved. In spring and early summer, when conception normally occurs, sexual activity is primed by the increasing-light photoperiod.

The timing of parturition in spring commonly coincides with abundant forage. Based on the 10-year study of Camargue horses, Duncan (1992) found striking the coincidence of the normal median birth date and the peak of diet quality.

Following parturition, mares tend to exhibit renewed bouts of sexual interest. Berger (1986) found seasonal influences affected these postpartum estrous periods in feral horses of northwestern Nevada. Mares giving birth prior to 1 April averaged 24 days until estrus, whereas mares giving birth later came into postpartum estrus almost two weeks earlier (mean = 10.9 days). In the Camargue, Duncan (1992) noted mares came into postpartum estrus sooner when food was superabundant; subsequently, in those years the next foal was born in less than one year. When mares got ample food,

the median interval between successive births was 348 days, but in years when maternal condition declined the interval was 373 days. Primiparous mares gave birth on the average nearly a month later than multiparous females.

Seasonal factors are not the only influences over the time of parturition. For example, whenever a stallion succeeds in taking over a harem, the timing of parturition by mares in that group may be affected. In the takeovers observed by Berger (1986), 56 percent of the subsequent births by mature harem females occurred within 6 months of the takeover; whereas 44 percent of the births occurred about a year later. He concluded mares pregnant for 6 months or more maintained their pregnancy to full term, but pregnancy seemed to be disrupted in mares less than 6 months into their pregnancy when the new stallion arrived.

To some extent, mares maintain control over the time of a foal's birth by being able to prolong the initial stage of parturition if disturbed (Koch 1951). Mares tend to give birth during darkness or in the early morning hours when light levels are low and disturbances are greatly reduced. As an example, of the 36 births Berger (1986) obtained precise data, 86 percent occurred at night or around dawn. Five of the births occurred from 0900 to 1600 hrs; of these, four were by primiparous females.

— Influences on Development, Sexual Maturity, — — and Dispersal —

Maternal characteristics influence the fate of foals. For example, Duncan (1992) concluded neonatal mortality (0–2 days of age) of Camargue horses was higher in foals of 2- to 3-year-old mares than in foals of older females. Surviving foals of 2- to 3-year-old fillies remained on the average 30 kg lighter at any given age than foals of older mares. Even foals of mothers 5–6 years of age weighed 10 kg less than foals of more mature mothers. The mother's weight was not in itself the main determinant of foal weight; instead, mares who had not completed their own growth seemed to grow at the expense of their foal. In nutritionally difficult years, mothers spent a greater part of the year lactating than in easier years. Non-pregnant mares lactated on the average almost 28 weeks longer than pregnant mares; as a result, yearlings of barren females were visibly larger than their peers. The gender of the foal had no effect on its weight or on the length of lactation. However, social status of the mother was a factor regarding foal weight. Foals of dominant mares were 7.9 kg heavier per unit difference in rank.

In the study by Berger (1986), differences in nursing-bout durations were greatest between foals from high- and low-quality areas during the first two weeks of age. Foals of the high-quality areas averaged more than a minute per hour longer in nursing duration than those of the low-quality areas. Males suckled longer than females. Individuals from better-quality home ranges exhibited juvenile dispersal earlier, seemingly reached puberty sooner, and (for females) produced offspring sooner than individuals from low-quality areas.

Presenting 15 years of data on Assateague Island ponies, Rutberg and Keiper (1993) noted young males delayed dispersal from their natal group when peers were available for interaction within their group. The correlation was significant for both total number of peers as well as number of same-sex peers in the natal band. Female dispersal from their natal group was not influenced by number of peers, but was correlated with age of first reproduction. Females that dispersed earlier gave birth significantly earlier than females who dispersed later. The presence of a newborn sibling per se was not an influence for the dispersal of either males or females. Not all females dispersed from their natal group, although 81 percent did by the age of 5 years (mean = 24.6 months). Whereas, 97 percent of males dispersed from their natal band (mean = 20.8 months). In Berger's study (1986), dispersal was typical of both males and females. The average dispersal age for females was 2.01 years and for males, 2.2 years; males moved farther from natal ranges (mean = 3.3 km) than females (mean = 0.5 km).

For at least males, dispersal seems related to social environment. Observations have been made of harem stallions seemingly expelling young males from their natal band; yet, forced dispersal appears not to be the norm for either colts or fillies. Young males seem to develop a need for male-male interactions. That need may be satisfied for awhile within the natal group (cf. Rutberg and Keiper 1993); nevertheless, eventually the developing male departs and interacts with peers elsewhere—long before attempting to become a harem stallion. As a family band moves about its range, it encounters bachelors among other things; these encounters influence colts in the band. Berger (1986) noticed that 26 percent of the young males that dispersed permanently from their natal band had at least once in the past departed and engaged in social interactions with bachelors. Young males persisted in interacting with bachelors even when initially they were nipped, chased, and even mounted. Rutberg and Keiper (1993) found no evidence that band stability influenced the age of dispersal from the natal group, nor was age of the band stallion or mother an important factor regarding dispersal.

To understand why on Assateague Island a relatively high number of young females remained in their natal bands, Rutberg and Keiper (1993) further analyzed their data. Since female juvenile dispersal in equids is a mechanism to prevent close inbreeding, perhaps the females failed to disperse when the band stallion was not their father. Precise paternity was not known; nonetheless, harem takeovers tend to be by younger, not older, stallions. The Assateague data showed that non-dispersing females belonged to a band having a younger stallion (mean = 7.3 years) than bands where dispersal occurred (mean = 9.6 years). However, following their birth, females that failed to disperse were no more likely to experience a change in their band stallion than females who did disperse. The data revealed the mothers of non-dispersing females were significantly lower in dominance rank than mothers of dispersing females. Perhaps differential growth and delayed puberty were involved. Maternal age and band size had no significant effects on the likelihood of dispersal. Whatever the underlying cause for some females not dispersing, it resulted in those females having reduced reproductive success. It is likely poor-quality forage on the island was impacting development, dispersal, and reproduction (cf. Keiper and Houpt 1984).

Factors Influencing Social Structure and Stability

Most males remain alone or in bachelor groups when unable to obtain a harem. Bachelor bands can be temporary; they commonly are flexible in composition—individuals come and go. Harem bands usually contain a single stallion; however, multi-male harem bands are occasionally seen. In the Granite Range population, Berger (1986) determined 2- to 5-year-old males were alone only 2 percent of the time; males 6 to 14 years of age were alone 8 percent of the time; and males 14 and older were alone up to a maximum of 35 percent of the time.

Harem bands tend to remain intact throughout the year. When bands encounter each other, typically threat displays are exchanged between groups; direct contact is normally avoided. Following the encounter, usually the bands continue their separate ways without a fight. At sources of water, usually an arriving band will wait at a distance until a previous band finishes drinking and departs. When use of the site is contested by an intruding group, Franke Stevens (1988) found the band first using the site retained possession in 80 percent of the cases.

When males lose their position as a harem stallion, it is usually through aggressive encounters with other adult males. Berger (1986) noted males

that lacked harems were more likely to be aggressive and tended to challenge harem stallions. Young males were not successful in holding harems (3- to 5-year-olds averaged less than a week).

In the Granite Range, stallions with larger harems expended more total energy in defense of their mates than those with smaller harems; yet, they expended less energy per female (Berger 1986). Older stallions expended the least energy, but this is mostly because they opted to live on home ranges of the lowest quality and thus minimized costly encounters. Berger calculated the most active males expended 48 M-joules/day over basal rate; this value exceeded by about 700 percent the energy spent in harem defense by the least active stallions. Stallions that expended the most energy for harem defense had the advantage of feeding in the highest-quality range. Injuries from fighting were not uncommon; in any given year, bite wounds were evident on 97 percent of adult males. During the study, about 3 percent of the males died as a result of fighting and most mature males had noticeable scars.

Harem bands containing more than one stallion are defended as a multi-male partnership (Welsh 1975; Denniston 1980; Miller 1980; Berger 1986). The size of multi-male harem bands is often larger than single-male harem units. One stallion is dominant in social rank over the others. Although the males may support each other, the defense effort is not necessarily equal. Berger (1986) reported the dominant stallion initiated harem defense significantly less often than subordinates, thus subordinates ran the risk of injury more than did dominant stallions. He found the partnerships did not confer greater reproductive advantage per male nor did they result in a stable relationship. Linklater and Cameron (2000) found little cooperative behavior among stallions in the multi-male harem bands they observed and such bands had significantly poorer reproductive success.

Of the 17 multi-male harem bands that formed in Berger's study (1986), only two exceeded 7 months in duration. Most partnerships were among young males that obtained their first females. Older males were involved in the two relatively-stable associations, one lasted 2.5 years (males were 11 and 17 years) and the other lasted 4 years (males were 11 and 14 years of age). In Miller's study (1980) and that of Franke Stevens (1990), multi-male bands appeared more stable than single-stallion bands. Feh (1999) reported occasions where two stallions were affiliated with the same harem band for years (one case lasted more than 16 years).

To some extent, group stability is a characteristic of age; yet, ecologically, forage availability can be a factor (cf. Franke Stevens 1990). Based on 5 years of data, Berger (1986) found group stability for older females was

greater than for younger females. Though the population was increasing, the mean harem size changed little from year to year, leading to the conclusion older males were not consistently monopolizing females. Of the mares that left a group, direct male appropriations accounted for 55 percent of the cases; for the other changes noted, mares simply wandered away from their previous companions. Rutberg (1990) found bands accompanied by older stallions had fewer changes in adult membership than bands accompanied by younger stallions. Bands were larger and more stable with the older and more experienced stallions (those who had held a band for 2 or more years). Although band size tends to increase as the stallion gets older, eventually a peak is reached (e.g., between the ages of 6–9); subsequently, the band size gradually decreases (Kaseda and Khalil 1996).

— Influences on Reproductive Success —

Reproductive success in males is affected by such factors as body weight, age, fighting ability, home-range location, and reproductive lifespan. In females, reproductive success is especially affected by quality of home range, band stability, and body weight (Berger 1986). These factors are interactive. A male must acquire a harem to have access to mates; this requires fighting ability. Body size provides an advantage. Males in their physical prime do better than those too young or too old. High-quality home ranges are occupied primarily by bands of prime-aged stallions. Good forage leads to quality body condition of all band members. Mares in good condition produce more offspring. And well-nourished young do better regarding survival, development, and so on.

Dominant mares may have better quality diets than subordinates but apparently do not have higher reproductive success. The long-term studies by Berger (1986) and Duncan (1992) found no support for the idea that dominant mares produce more foals than subordinate mares. Yet offspring may incur advantage. The foals of dominant mares have been found to be heavier (Duncan 1992). Being more nourished, daughters of dominant mares tend to mature earlier and thus have a longer reproductive lifespan. Sons of dominant mares may have higher reproductive success (Feh 1990), but body weight per se appears not to be the reason.

High-quality home ranges yield broad reproductive benefits. Reproduction begins earlier in well-fed fillies. For example, comparing fillies reared on different quality home ranges, Berger (1986) found all three females from high-quality areas produced foals at 2 years of age, 1 in 6 of those from medium-quality areas had a foal at two years, and none of the females

from poor-quality areas produced offspring before the age of three. Overall, small and poorly conditioned mares had shorter gestation lengths and lower foal production. It seemed the smaller or lighter individuals emerged from winters in the poorest condition and lacked body reserves to prolong gestation. Late-term abortion occurred in some physiologically stressed mares. Duncan (1992) found in years where the mother's body condition was depressed there was proportional mortality in foals during the first 48 hours postpartum.

No differences in maternal behavior toward sons and daughters has been revealed by population level analyses. However, based on a study of feral horses of New Zealand, Cameron and Linklater (2000) incorporated mare condition into their analysis and concluded sons were more costly to mares in good condition; daughters were more costly to mares in poor condition, although no maternal behavior differences were found. As mentioned earlier, in the Camargue horses observed by Duncan et al. (1984b), colts spent 40 percent more time suckling than fillies during the first 8 weeks; body weight did not differ between sexes, but male foals grazed less and were more active. Berger (1986) noted that foals, whose mothers fed on high-quality range, averaged more than a minute longer in suckling duration than foals whose mothers lived on low-quality habitat. Speculation is tempting; however, the amount of milk transferred to a foal during nursing cannot be predicted from nursing duration, nursing frequency, or other behavioral traits typically recorded (Cameron et al. 1999b).

If a mare's reproductive success can be affected by environmental factors, what about stressful situations where humans are in control? Baucus et al. (1990a,b) found stress in mares did occur during transport, but it did not alter aspects of the estrous cycle or cause early embryonic deaths. Hansen and Mosley (2000) looked at the effects of roundups on horse reproduction. Basing their study on feral horses of Idaho and Wyoming which were monitored for a year, they found no difference in the foaling success rates of the three treatment groups—control mares, mares gathered by helicopter but not captured, versus mares experiencing roundup by helicopter plus capture and transport.

A male's lifetime reproductive success is constrained by the span of time he is a harem stallion. Often he is sexually mature long before obtaining a harem and is displaced before reaching old age. Berger (1986) estimated a male that might live to 15 years would produce on average 16.2 foals. In the Granite Range study, the most successful stallion sired over 20 foals by the time he was nine. But some males apparently never bred, and for those that did the average harem tenure was less than 4 years. Seven percent of the stallions sired 29 percent of the foals. Thus, reproductive-success variability is

considerable between males. But the potential number of progeny successful harem males can leave behind is greater than for females. Kaseda and Khalil (1996) determined paternity by blood typing in 99 foals born in stable harem groups and found the harem stallion of the foal's natal band sired 85 percent of the foals. Two stallions monitored in detail from 1979 to 1994 produced 24 and 25 foals in the 10 and 11 years of their reproductive lifetime. The study also showed males that maintained large harems (e.g., seven mares) sired fewer foals than males with smaller harems (e.g., two to five mares), apparently because of challenges by rivals. In the Great Basin study of Bowling and Touchberry (1990), blood typing revealed about one-third of the foals in a harem band were not sired by the band stallion. In single-stallion as well as multi-stallion harem bands, about half of the foals were sired by the dominant/resident male. Feh (1999) reported subordinate males of multi-male harem bands sired about a quarter of the foals. Such data indicate stallions outside of the band are successfully breeding with some harem-band mares and producing a number of offspring. Those males may be stallions from other bands or bachelors. Thus, studies of paternity have disclosed that harem stallions do not successfully maintain exclusive breeding rights and are not necessarily the sire of all offspring in their band. Non-band males, perhaps bachelors, are thus achieving some reproductive success.

For a female, lifetime reproductive success is especially constrained by her life span. Compared to males, females breed earlier and throughout their life. From the Granite Range data, Berger (1986) estimated a mare that lived to 15 years would on average produce 10 offspring. But the average age of death in that population was 7.86 years for females and 7.23 for males. At the mean age of death, an average male would produce less than half the number of offspring as a female (1.60 versus 3.91). Nevertheless, for individuals that survived beyond the mean age of death, some males were more successful than equal-age females in leaving behind offspring. A high percentage of harem stallions were 7–14 years old.

Band stability has an effect on foal production. Kaseda et al. (1995) used foaling interval (i.e., time between successive births) as a means to estimate the reproductive success of feral mares. Over a span of 5 years, mares that remained in a stable harem situation had an average foaling interval of 364.5 days compared to mares that did not have such stability (mean = 387.0 days). Berger (1986) found females from stable bands had higher reproductive success than mares of unstable bands, such as those taken over by new stallions. Fourteen pregnant mares were monitored continuously before, during, and after male takeovers; 11 of these mares were less than 6 months pregnant.

Subsequent to the arrival of the new harem stallion, at least nine of the fetuses sired by the previous stallion died. In 12 of the 14 monitored females, reinsemination occurred by the new harem stallion but several of the resultant fetuses died. The new stallions forced copulation on most of the observed mares and achieved some degree of reproductive success. Nevertheless, had the takeovers not occurred, reproductive success of the mares would have been higher. Kirkpatrick and Turner (1991), investigating a different feral population, found no forced copulations or disruption in reproduction subsequent to changes in herd stallions.

Behavioral and Ecological Factors in Population Dynamics

Even where the habitat seems poor to human eyes, feral horse populations generally demonstrate noticeable reproductive potential and a capacity for population growth. For 12 feral horse populations (BLM management units), Garrott (1990) estimated finite annual growth rates (λ) ranged from 1.15–1.27 with mean of 1.21 (based on log-linear regression of aerial counts). Elsewhere, on Assateague Island National Seashore, the population has been observed to grow at a rate of approximately 11 percent per year (Keiper and Houpt 1984). In the Granite Range of Nevada, the horse population increased at the rate of 20 percent per year (Berger 1986). And in the Camargue herd of the Rhône Delta, the population grew at a rate of about 30 percent per year (Duncan 1992). The observed high rate of increase in these studies was related to the high survival rate and nearly predator-free environment. Limitation of food quality appears to be the major reason feral horse populations stabilize or decline (e.g., see Berger 1986; Franke Stevens 1991; Duncan 1992), aside from removal of horses by humans or a sudden calamitous event. By selective removal of very thin individuals, the Camargue herd was stabilized.

Various physiological means to control equine reproduction have been contemplated; the efficacy of their use to limit horse populations must be tested as well as the behavioral changes and other impacts that may occur. For example, selectively sterilizing harem stallions may reduce foaling but may not effectively control the population because females can move between bands and subordinate stallions or bachelor males may breed (Eagle et al. 1993). Powell (1999) studied porcine zona pellucida immunocontraception (PZP) for behavioral effects in feral horses. Observational sampling did not reveal significant differences between treated and untreated

mares in general activity budgets, aggression given or received, or spatial relationships relative to the stallion. But the observers noticed during the 3 months of data collection that the treated mares tended to engage in more social behavior. Long-term study would appear warranted. The immunocontraception only prevents egg fertilization not sexual behavior, thus treated mares continue to have repeated non-conceptive cycles and return to estrus at regular intervals (perhaps for much of the year). By contrast, the cyclic pattern, including estrus, does not occur during pregnancy; untreated mares normally are pregnant by late spring. Following PZP treatment, it appears to take mares 2–3 years to become pregnant.

Fecundity in horses increases with age, peaks about the age of nine, remains relatively high until about 18, then gradually diminishes. Some females in the Granite Range herd became pregnant as yearlings, about 37 percent of 2-year-olds foaled, 40 percent of 3-year-olds, nearly all of 7-year-olds, and about 70 percent of 18-year-olds; the years of greatest foal production were between the ages of 5 and 17 (Berger 1986). In the Camargue, Duncan (1992) noted 95 percent or more of the mares older than 7 years produced a foal each year, whereas fecundity of younger females was lower (e.g., 55–75 percent). Foalings per female were positively correlated with body weight and sensitive to food shortages. Fecundity of 2- and 3-year-olds declined precipitously in years with reduced food supply (which caused slower growth rates in younger females). The reasons for a decline in food supply can vary, but may be from factors such as population density or competition with other herbivores. Such factors become major when food supply is limited, reproduction is affected, and survival becomes an issue.

Mortality rates in horses normally are relatively low. For some studies, annual mortality rates of 7–14 percent have been observed (Feist and McCullough 1975; Boyd 1979; Keiper and Houpt 1984). In the feral horses of the Granite Range, Berger (1986) estimated the average mortality per year was 4.9 percent. But during the first year of life the mortality of foals was 8 percent. Nevertheless, a foal survival rate of 92 percent is commendable under wild conditions; predation was insignificant. For the foal deaths, Berger noted 70 percent occurred within the first month and, of these, 86 percent were within the first two days. Duncan (1992) found neonatal mortality (0–2 days) was higher in foals of 2- to 3-year-old mothers than in foals of older females. Nutritional and social instability factors (directly or indirectly affecting the foal, the mother, and her parental care) were identified as possible factors in neonatal mortality. Once foals survive to two days of age, mortality risk is much lower. Horse deaths due to injury, being

trapped in mud, starvation, dehydration, disease, aging, and other causes have been reported (e.g., see Berger 1983b). In the White Mountain feral horse population along the central California-Nevada border, mountain lion predation on foals has been reported to be as high as 45 percent (Turner and Morrison 2001).

The killing of foals by stallions is rare under normal range conditions. But it has been noted where humans have disrupted band stability by seasonally removing a stallion and then creating the circumstances of a new band stallion later when the stallion is subsequently released into a herd (cf. Tyler 1969; Duncan 1982). In foal-mauling and foal-fatality instances, the "new" stallion has been the aggressor. In times of social instability, such as following takeover of a band, invading stallions may (e.g., through harassment and physiological stress) induce abortions in pregnant mares (Berger 1983a; 1986).

The social dynamics in feral horse populations helps maintain genetic diversity. The alpha stallion of each harem band has substantial opportunity for mating but is unable to maintain sole breeding rights. Often a portion of the foals in a harem band are sired by males not residing in that band. And, inbreeding is minimal. This is, in part, because of the tendency for offspring to depart their natal band at or before sexual maturity, thus, as adults, opposite-sex kin are not likely to be members of the same band. In cases where fillies delay departure from the natal band, stallions rarely show sexual interest toward juvenile females. In a study of 14 Camargue horses left unmanaged to propagate for six years, Duncan et al. (1984a) found inbreeding remained low for the 58 foals produced (median inbreeding coefficient <0.04 each year). The investigators attributed the low relatedness was due to the avoidance of mother-son pairings, lack of sexual behavior between fillies and the stallion of their natal band, and lack of sexual interest between maternal siblings which had been contemporary during development.

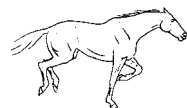
In essence, horses exhibit reduced level of sexual activity toward juvenile members of their social group—not kin recognition per se. Berger and Cunningham (1987) monitored 32 young females as they first reached sexual maturity; in none of the observed copulations did fathers or stepfathers mate, or attempt to mate, with females that matured sexually within their bands. Familiarity seems to be a factor; yet once emigration occurs that mechanism wanes. Cases have been observed where stallions have mated with their daughters (or stepdaughters), but in those instances the individuals involved had been separated for many months.

Part VII



Applied Ethology in Horse Care and Management

23 Behavioral Considerations in Horse Management



The management of horses is most successful when knowledge about equine behavior is applied. Success is more likely to be achieved when features of horse behavior are consonant with the design of a horse facility and its trails, with the design and use of the buildings and each enclosure, with the plan for efficient operation and safety, with horse care and day to day maintenance of the facility, and during horse transport. This chapter reviews these points by considering enclosures and housing, social needs and human interaction, exercise and feeding, grooming and hoof care, horse handling equipment, and transport. Applied ethology of horse handling is the topic of Chapter 24. And behaviorial indicators relevant to the health and well-being of horses are covered in Chapter 25 plus the Appendix.

— Enclosures and Housing —

Safety is an important consideration in all aspects of horse management (cf. Potter and Yeates 1990). The location of the entire horse management unit (including trails, enclosures, and buildings) should be where horse-vehicle accidents are not likely to occur. Often horses do not see or recognize potential hazards, whether they be low-level pitfalls, objects overhead, or dangers elsewhere in their environment. Careful design, construction, and maintenance should eliminate situations that pose a safety problem. Occasionally horses become seriously injured by hitting fence posts or getting cut by fence materials. By way of example, barbed wire and gates with sharp edges should not be used for horse enclosures. And the risk of a horse colliding with a post can be reduced by placing the fencing material on the inside surface of the posts between the post and the horse enclosure itself. To reduce the temptation to jump a fence, the fence height should be approximately

1.5m (5 ft) for horses and 1.2m (4 ft) for ponies. The fence should be extended close enough to the ground to prevent a horse (e.g., a foal) from inadvertently passing under the fence while recumbent. When fences have low visibility, they should be marked with bright tape or fabric.

Pastures of high quality can supply most or all of the nutritional requirements of the horses and often satisfy the other maintenance needs, such as areas for resting, grooming, elimination, and free access to drinking water. Shade from extremes in solar radiation and shelter during winter storms can be provided by trees or artificial shelters. Maintenance of pastures is often needed to scatter or remove dung piles to broaden pasture utilization and perhaps reduce parasite problems, to remove weeds or rank vegetation by mowing, and to improve the turf in areas with heavy use. Overgrazing should be prevented by limiting horse density and by moving the herd from one pasture to another in a rotation fashion. Design and management foresight is often needed to prevent or reduce sites of erosion or excess trampling, for example, along passageways or at locations where horses gather in anticipation of supplementary food or some daily routine (e.g., opportunity to return to the stable). Also for safety, passageways should have good footing, have adequate width to avoid contact with barriers, and not require the animals to turn sharply upon entering, using, or leaving.

Enclosure characteristics can influence the behavior of horses. For example, normal maintenance and social activities may be constrained because space is limited. Resource limitations may cause other variations. Skiff (1982) observed two groups of Przewalski's horses at the Minnesota Zoo and noted when the horses were in a small enclosure (0.05 hectare) some exhibited coprophagia, pica, restless locomotion, more aggressive interactions, and more time in mutual grooming compared to when on pasture (3.5 hectares). Studying various zoo populations, Boyd (1991) found Przewalski's horses in enclosures less than 0.4 hectare in size exhibited greater variety of behavior per hour and spent less time resting, compared to when in large enclosures; she found no significant effect of enclosure size on aggressiveness, on time spent in mutual grooming, or in locomotion. Horses restless in small enclosures tended to show reduced restlessness when given hay ad libitum, when provided companionship, or when placed on pasture.

Spatial needs of horses vary with the situation. On pasture, horses need considerable space to effectively carry out social and maintenance activities. Individual distances (and perhaps other reactive distances) need to be accommodated. While resting, each horse in a group requires about 6m²; single-housed horses need 2 x withers height² (Zeeb 1981). While foraging,

horses separate by several body lengths and gradually move about the pasture selectively grazing. Overgrazing can occur if forage is limited and not all areas of the pasture are utilized equally. Some parts of the pasture are commonly used for defecation purposes and not grazing.

To assess how enclosure size affects horses, Kusunose et al. (1985) observed the behavior of yearling horses in enclosures of 0.2, 1.1, 1.5, 2.1, and 4.2 hectares. They concluded the horses interacted more frequently and grazed longer in the three larger fields. The canter locomotion was noticeably restricted in fields less than 2.1 hectares. To determine the effect of pasture shape, Kusunose et al. (1987) observed yearling Thoroughbreds on three 2.4 hectares pastures, each having a distinctive width/length ratio—1:1, 1:2, or 1:4. They found the horses grazed more evenly in the 1:1 pasture and changed direction less when cantering. Occasionally, by enlarging an enclosure or adding complexity to the landscape, certain social or other behavior problems can be resolved (Kolter and Zimmermann 1988).

In close confinement, horses are often placed in box stalls or tie stalls. For the animal's well-being, ceiling height should clearly exceed the head and ears when the neck is fully elevated in an alert posture. Walls should be solid planking to withstand kicking and other abuse. Wall height should be at or above 2m; above the level of 1.5m, the construction can be made to facilitate air flow and visibility. A box stall with sides of 3–4m in length is usually adequate for an individual horse; a mare housed with a foal as well as individual stallions are often provided more space. Tie stalls can be as small as 1.5 by 3m, but this method of confinement increases the risk of leg and foot problems because the horse's ability to move and change posture is restricted. Doorway width should be approximately 1.4m and door height should be at least 2.1m for a medium-size horse (cf. Ewing et al. 1999). Doors should be sliding doors or hinged to open outward; thus access to the stall is possible even when a horse is recumbent next to the door. Door latches should securely close and be horse-proof (i.e., not operable by horses). To minimize collision risks, doors should not be left protruding into passageways.

Barn construction should be designed for both horse and human occupants. Fire safety warrants continued consideration, including the materials utilized, method of construction, items stored, storage techniques, evacuation plan and escape routes, fire fighting equipment, smoke alarms, and so on. Periodic fire drills train personnel and emergency drills to evacuate the barn help inform the horses what is expected of them. The procedures and maintenance program of the stable should perpetuate a healthy and safe environment.

The building site needs to be where air quality and drainage are good. A ventilation system should be included in the facility to regulate air flow. When warm, horses need air movement to cool themselves. As needed, they perspire and utilize evaporative cooling, thus air flow and access to drinking water are important. Dry conditions should prevail along walkways and in stalls. Waste materials should not be allowed to accumulate anywhere in the stable. Bedding can be effectively used as a floor covering in stalls to absorb moisture and provide a soft surface. When given a choice, horses prefer to lie on bedding. Although Hunter and Houpt (1989) ascertained no clear preference for either straw or wood shavings. Mills et al. (2000) also using a 2-choice testing procedure concluded their horses preferred straw, then shavings, and lastly paper.

Electrical switches, tools, tack, and other paraphernalia need to be accessible to humans but should not be placed where horses can manipulate them. Lighting should be sufficient to permit good visibility along corridors and routes to and from each stall. Lighting within stalls should be available too. When horses in a dark stall environment were provided an opportunity to turn on the lights, Houpt and Houpt (1988) found the horses seemed to prefer a lighted environment, at least for part of the day. Light fixtures should not be accessible to horses and the bulb should be covered with a safety lens. Electrical wires should be in conduits and not accessible to manipulation by horses.

Basically, stable design should safely accommodate and provide for the needs of the horses; the facility should also be safe, practical, and efficient for stable workers to fulfill their responsibilities. Furthermore, barn design and procedures need to minimize invasion by vermin, by utilizing secure food storage bins and providing little opportunity for pest animals to seek shelter in or around the stable. Storage areas should be kept clean and sealed. Horses should be fed in a way that food can be totally consumed, without being scattered, and not readily accessible to pest animals. The timely removal of spilled food is prudent. Often it is easier to dissuade pests than it is to evict them once established. To discourage birds from using the stable as a site to roost or nest, overhead spaces (e.g., ceilings) should be relatively smooth and free of perches or nest attachment surfaces. The use of owl models placed in conspicuous, elevated sites within the barn may also help.

Social Needs and Human Interaction

Social needs of horses plus the tendency to establish dominance hierarchies should be accommodated whenever possible. To minimize the occurrence

of aberrant behavior, the social arrangements should approximate what would occur under wild conditions. Of course, risk of injury and undesired sexual activity must be given consideration. Often, mares and young are grouped separately from adult males. Males can be grouped with peers as bachelor groups, although many horse farms keep stallions isolated except for breeding. Horses deprived of social companionship are at risk for developing aberrant behaviors, especially when kept in close confinement. Even when socially deprived for relatively short periods, Houpt and Houpt (1988) found totally isolated horses were three times more active and spent less time eating than on occasions when visual, auditory, or physical contact could be made with other horses. Mal et al. (1991) reported socially-isolated mares of medium temperament spent more time eating grain, more time trotting, and traveled further than mares with social contact.

Especially at single-horse stables, humans provide much of the social contact horses experience from day to day. Stable workers often overlook this role. Humans can provide visual, auditory, and physical contact and help, to some degree, satisfy the social needs of a horse, especially when the interaction is amicable. Involving the horse in the interaction probably provides more benefit than simply allowing the horse to be a spectator. Periodical direct contact by human handlers was found to help horses reduce fear responses when approached subsequently by a human later (e.g., McCann et al. 1988b).

Reproductive success can be influenced by handling and management. Traditional practices are not necessarily optimum. For example, McDonnell (2000) identified changes in handling and management that might improve reproductive efficiency and reduce breeding problems within the horse industry.

Certain types of human contact cause a horse to react negatively or in an undesirable fashion. For example, a thoughtless stable worker who uses fright-inducing actions and sounds to drive a horse in and out of the stable tends to create a horse who avoids approaching humans. A head shy horse oftentimes has previously experienced a blow or other abuse toward that part of the body. Each human-horse interaction should cause benefit and not harm to the horse's training and tractability. All direct and indirect contact with a horse should advance the human-horse relationship and the horse's welfare in a positive way.

Exercise and Feeding

Regular exercise is good for the physiological and psychological health of a horse. It improves and maintains the stamina and physical condition of

the body. It gives variation to a horse's day, thwarts boredom, and provides a release for a confined horse's excess energy. Thus, exercise can help impede the onset or occurrence of aberrant behaviors. Exercise can be a specific program or gained during work activities or be a part of training sessions. More than one exercise activity per day is beneficial. Variation in type and duration may be helpful to develop the body and motivate the horse.

Besides exercise, good nutrition is important to the health of horses. Food and water should be easily accessible and free of contamination. McDonnell et al. (1999) concluded various intermittent as well as continuous water delivery systems can satisfy the needs of horses. Containers for food and water should be positioned where horses will not become injured and workers can easily service them. Within stalls, hay can be provided in a corner on the floor or in a rack. When a rack is used, the height should not be so high the horse inadvertently inhales or ingests dust. When the animals are kept in groups, dominance-subordinate relationships may leave some individuals with restricted access to food or water. Some arrangement may be needed to correct this situation, for example, by adding more containers or space at the containers or by using dividers to allow multiple access to the resource. Holmes et al. (1987) found a wire-mesh head divider on a 112-cm feed trough facilitated the feeding by subordinates in the presence of dominant individuals. When horses harmoniously share grain from the same container, they are usually parent and immature offspring (Boyd 1991).

Frequent feedings (e.g., 2 to 3 times per day) in small amounts are recommended to avoid ingestion-related problems, such as gastric distention, founder, and colic. Frequent feedings give variation to a horse's day and reduce boredom. Maintaining a regular schedule is recommended; horses are more at ease when they can predict events of the day. The amount of feed needs to be carefully regulated and adjusted to the horse's activity routine and digestive physiology. Changes in the type of food or in the schedule should be done gradually (Hintz 1990).

Choosing the diet for horses is an important management decision for the health, well-being, and utility of horses. A conservative diet is usually preferable. However, some horse owners are induced to try each new feed supplement or formulation; yet the outcome may be disappointing. For example, Holland et al. (1996) monitored the behavior of horses fed a diet supplemented with (i) corn oil, (ii) soy lecithin plus corn oil, or (iii) soy lecithin plus soy oil. Compared to the performance of the horses fed a standard ration, the investigators concluded dietary fats reduced the activity as

well as reactivity of the treated horses. For horses that get a major portion of their nutrition from prepared rations, it is important during quiet times to provide them something to occupy their day. This is usually done by providing a source of roughage, such as good-quality hay (cf. Hintz 1990). Hay provides some nutrition; yet, from a behavioral point of view, it gives a horse something to manipulate and savor; it takes time to consume. Thus, it minimizes the problem of boredom and occupies the horse for long periods.

Grooming and Hoof Care

Grooming is an opportunity to socialize with the horse while also providing physical and physiological benefits. Certainly the hair coat benefits from the rubbing and brushing. Cleansing occurs, ticks can be discovered and dislodged, and loose hair removed. The skin and musculature benefit from a well-executed massage, circulation is enhanced, and tone improves. If the handler is skillful, the horse learns to accept and appreciate the grooming activity. Grooming prior to a working session prepares and cleans areas that need special attention or may receive harm from a girth, saddle, or other equipment if left soiled. Grooming also is a mild way to initiate the work session. Following the work activity, another bout of grooming should follow. It aids the cool-down process and allows the handler to again socialize with the horse unencumbered by the work routine. When vigorous activity has occurred, special procedures may be needed to properly cool the horse before it is return to its stall or turned out. The handler should utilize grooming sessions and other opportunities to evaluate the horse's health and well-being. Behavior changes should especially be noted and evaluated.

Attention to the legs and especially the feet should be part of every grooming session. Hoof care is not just the responsibility of the farrier. For example, the ventral surface of the foot should be kept free of debris, monitored for soundness, and restored as needed (cf. Evans 1990). Horse handlers should assist in keeping the legs, hooves, and locomotion of each horse free of problems. Each hoof should be able to impact the ground comfortably and maintain satisfactory alignment and angles of the limb to accomplish the locomotor demands placed on the horse. Changes in the posture and motor patterns of the horse should be noted and assessed. Specific behavioral cues characterize each type of lameness as well as the adjustments made by the horse to ease discomfort (cf. Florian Buchner 2001). Treatment and remedial action should focus on the long-term

health and well-being of the horse. Foot trimming and shoeing should be based on hoof mechanics and individualized to the needs of each horse. Adjustments are possible to correct or lessen problems in hoof or leg action. Manipulations of the hoof are feasible during trimming and shoeing that can modify angles relative to the substrate, shift pressure points, and improve the action of the foot during locomotion (cf. Back 2001).

Horse Handling Equipment

Behavioral effects should be considered when choosing and utilizing various types of equipment on horses. The horse handler should understand the purpose for each equipment item, how to properly fit it to the horse, plus how to apply it. Behavioral problems can occur from ill-fitting equipment or its misuse. Bits, bridles, saddles, harness, and other horse equipment need to be of the type and design required for the specific situation. The equipment applied to a horse should fit comfortably, not be unnecessarily distracting, and not cause harm. And the equipment should be carefully adjusted to fit the size and specific features of each horse. The proper fitting process should include all subcomponents, such as the noseband, cheek pieces, and curb strap. Occasionally there is need to use protective devices, such as boots, to prevent the horse from injuring itself; the type of device should be chosen for the specific need and fitted properly. Some equipment is used to control behavior, such as martingales (used to limit head and neck motion) and racing hobbles (used to help coordinate limb movement in pacers); as with other equipment, a proper fit is important. Action devices, such as ankle rattlers and chains, are a special class of equipment used to accentuate action of the legs; proper application is prudent.

Some horse handling equipment is carried or regularly manipulated by the handler. To get favorable behavioral results, the equipment needs judicious use. These items include reins, longe lines, and whips. A long whip extends the reach of the handler and is often used as a visual or auditory stimulus while working the horse from a ground position. A short whip is commonly used as a tactile device (i.e., for punishment or negative reinforcement) while riding the horse.

Transport

Loading and transport creates a degree of stress for both horse and handler. For the handler, it is the overall task of getting the horse safely and

successfully transported, which includes loading and unloading. During transport, stress-indicating hormonal and plasma ascorbic acid changes occur in the horse (e.g., Baucus et al. 1990a,b). For the horse, uncertainties are at least part of the stress. Stress is less the more the animal has experienced successful loading and transport. Yet, even older horses show an elevated heart rate during transport. Waran and Cuddeford (1995) noted heart rate elevated an average of 18 beats per minute higher in transport than while stationary ($n = 32$ horses, representing all ages). Feeding occurred less during transport. Evasive behavior during loading occurred in the youngest, most-naïve horses. The average time it took to load yearlings (368 sec) was much greater than for 2-year-olds (30 sec), 3-year-olds (22 sec), or horses greater than 3 years (5 sec).

When loading a horse, prepare the situation to assure success and a safe procedure. Have an assistant on hand. Prevent personal injury with safety equipment and thoughtful procedures. Be sure the loading platform or ramp is secure, steady, and provides safe footing. Position the trailer or van in a way that the horse is encouraged to load and has no alternative (i.e., escape) route. Provide good visibility and ample room for the horse to enter the transport vehicle. Maintain a steady and calm demeanor. With at least some horses who regularly resist loading, the problem may have intensified because the horse associates prior unpleasant experiences with loading.

Before major transport is needed, it is helpful to train the naïve horse, using a sequential series of lessons to successfully approach the loading area, stand on the loading platform or ramp, enter and leave the transport vehicle, and accomplish short drives to develop confidence and balance skills. For older horses who remain evasive to loading or misbehave during transport, it may be necessary to pursue a program of desensitizing and counterconditioning (see Chapter 24; Houpt 1986).

The stress induced by transporting horses can be reduced by providing conditions with favorable noise levels, temperature, air flow, humidity, secure footing, physical space, as well as stabilized air pressure within aircraft. Orientation parallel to the line of travel seems to cause less restlessness upon starting and stopping than a transverse position. Cregier (1979; 1981; 1982) concluded that facing horses away from the direction of travel in trailers and vans greatly reduced physiological as well as psychological stress, especially during braking. To achieve balanced transport, a horse in the rear-facing position must be permitted room to raise, lower, and turn its head. Backing the horse into a rear-facing trailer compartment circumvents the fear horses have of walking into a darkened area. Clark et al. (1988;

1993) monitored rear- and forward-facing naive horses during transport and concluded rear-facing horses were better able to maintain their footing. The rear-facing horses had fewer impacts against the sides of the trailer, fewer total impacts, fewer losses of balance, and tended to have a lower heart rate during the initial 15 sec of travel.

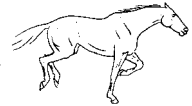
Smith et al. (1994a) monitored horses tethered during transport. Heart rates were not significantly different between horses facing forward or backward during transport; although, heart rates were significantly higher during transport than while stationary. Subsequently, Smith et al. (1994b) studied the behavior of individual horses ($n = 8$) loose in a 4-horse stock trailer. The horses spent significantly more time facing backward (65 percent) during transport but showed no preference for direction when stationary.

Waran et al. (1996) tested horses ($n = 6$) as pairs in a lorry and found average heart rate was significantly lower when the horses were transported facing backward. Forward facing horses moved more frequently, vocalized more, and held their necks in a higher than normal position. During loading the average peak heart rate was 38 bpm lower when the horses were backed into the horsebox for rear-facing transport compared to forward orientation.

Gibbs and Friend (1999) allowed mature horses (mean age = 10.6 years) to exhibit the transport orientation they each preferred when tested in a 16m long, topless, single deck, 16-wheel trailer. The trailer had leaf-spring suspension, 1.7m walls, and a textured aluminum deck with no bedding. The test route was 14.4 km and consisted of bumps, turns of various angles, straight-aways, speed changes, and hard stops. The 12 test horses experienced three experimental treatments: tied to the left side of the trailer (TL), tied to the right side (TR), or loose. Horses were tested in groups of four. For each horse, the orientation angle and the time spent at that angle was recorded using overhead video cameras. In the TL condition, the horses spent 52 percent of the time facing away from the direction of travel with their hindquarters angled 22–67° away from the left side of the trailer. In the TR condition, the horses spent 59 percent of the time oriented in the direction of travel with their hindquarters angled 22–67° away from the right side of the trailer. In the loose condition, the horses exhibited a full 360° range of orientations, with facing more or less in the direction of travel the most common (62 percent). No directional preference was shown when horses were transported in high- versus low-density groups (Collins et al. 2000).

To compare the effect of different orientation angles on behavior exhibited as well as on the ability of the horses to maintain their balance during transport, Gibbs and Friend (1999) conducted another experiment. During each trial, four horses were individually confined in 3.6 x 0.76m compartments and transported in the 16m trailer used in the first experiment. The four orientations tested with unshod horses were slanted 45° backward, slanted 45° forward, parallel to direction of travel, and parallel away from direction of travel. A group of shod horses were also tested in the parallel forward and parallel backward orientations. Observers within the trailer recorded leg movements, leans, bumps, pawing, vocalizations, urinations, defecations, kicks, slips, and falls. Horses in the parallel backwards treatment slipped significantly more often than in any of the other orientation treatments. There were no other orientation effects on the variables measured. Unshod horses had more foreleg movement than shod horses; otherwise, being shod had no measurable effect.

24 Behavioral Manipulation



Numerous techniques have been devised for manipulating the behavior of horses. Rarely are experimental data available as to their effectiveness. The intent here is not to review or critique the many techniques but to emphasize basic concepts of effective handling as supported through empirical evidence and to provide some guidance not only to achieve success but also to minimize stress for both the horse and handler.

By reducing the number of factors causing stress, manipulation is made easier. Thus training is typically conducted in a familiar, rather than strange, environment. Stress can often be kept to a minimum by gradually exposing a horse to new stimuli and situations. For example, the frequency of occurrence, intensity, speed of onset, and duration of new stimuli or novel situations can usually be controlled and innocuously established over several training sessions rather than initially at full strength. Habituation and learning set formation can be applied (see Chapter 7). With repeated stimulation and experiences, adaptation proceeds and the horse tends to adapt to subsequent new situations with increasing ease. Csapó (1972) applied these steps when weaning foals. By gradually and sequentially altering the close association of mare and foal, weaning was accomplished without the physiological and psychological stress shown by the abruptly weaned foals of the control group. Houpt et al. (1984) found housing newly-weaned foals as pairs rather than individually was less stressful. And McCall et al. (1985) ascertained foals weaned by partial separation from their mother (i.e., allowing visual, auditory, and olfactory contact between foal and mare) resulted in fewer signs of foal stress compared to weanlings experiencing total separation.

The ease and effectiveness of behavioral manipulation and restraint can be greatly enhanced when a handler takes into account the innate tendencies,

prior experiences, and learning of the horse. For example, a swift and focused approach toward an unhandled horse can initiate a flight response at a considerable distance (see Reactive Distances, Chapter 3). The withdrawal effort and flight distance will be less if the handler's approach is slower and more indifferent. As repeated approaches occur and the horse experiences no adverse impact from the approaches, the result will be a diminished flight response. Further steps to habituate the horse to human interaction can then be instituted without applying restraint. A horse that associates an approaching handler with unpleasant experiences will subsequently show avoidance. In such a case, counterconditioning with a program of positive reinforcement can be an effective procedure to overcome the avoidance trait. Although time and patience are required, the risk to horse and handler is minimal.

Reflexes can inadvertently hinder or be used to advantage during behavioral manipulation (cf. Rooney 1981). Postural reflexes can induce either extension or flexion of the legs. To more easily persuade a naive foal to pick up its left hindfoot, an assistant can activate vestibular and neck reflexes by turning the head to the right and lift the head and neck slightly with a hand under the chin. The right legs extend but the left tend to flex thereby aiding the lifting of the left hindfoot. Similarly, lifting of the left forefoot can be induced by a right head turn, but this time the neck is flexed ventrally by hand pressure on the nose (Rooney 1979).

Early Experience and Human Socialization

Beginning human contact early in the life of a foal can potentially establish a close relationship with humans that may facilitate subsequent handling and training (e.g., see Marwick 1967). The sensitive period to establish initial social relationships in a foal commences very soon after birth (Waring 1970b). It is well known that in puppies primary socialization can be accomplished to both dogs as well as human handlers (e.g., see Pfaffenberger and Scott 1959; Fox 1965). Both passive human exposure as well as active handling procedures were found to be effective in dogs (Stanley and Elliot 1962; Stanley 1965). Our work in the 1960s and 1970s was based on the potential that foals, too, might establish a long-term association to their own species as well as to humans during their sensitive period. To pursue this idea, I exposed newborn American Saddlebred foals to various degrees of human contact beginning as early as 5 minutes to as late as 15 hours

postpartum. To avoid imprinting foals exclusively to humans, an effort was made to not disrupt the development of the mare-foal relationship.

The results were encouraging but not conclusive. Our 1969 experiment can serve as an illustration. Two foals were separated from their mother 5 minutes after birth and actively human fondled until returned to their mother at 70 minutes of age. A third foal, in the presence of its mother, received passive human exposure by a person sitting in the foaling stall from 1 to 6 hours postpartum. A fourth foal was supplementally bottle fed at hour 5 and 6 and had a human mannequin (Figure 24.1) in the foaling stall until 83 hours of age. The fifth and sixth foals were exposed to the mannequin for 40 and 84 hours, respectively.

To test the effect of their early experience treatment, the first five foals (I-V) were individually halter-led away from the barn for 10 to 15 minutes during their first day. The handler directed and reinforced the foals using tactile and vocal stimuli. A second handler led the mother nearby.

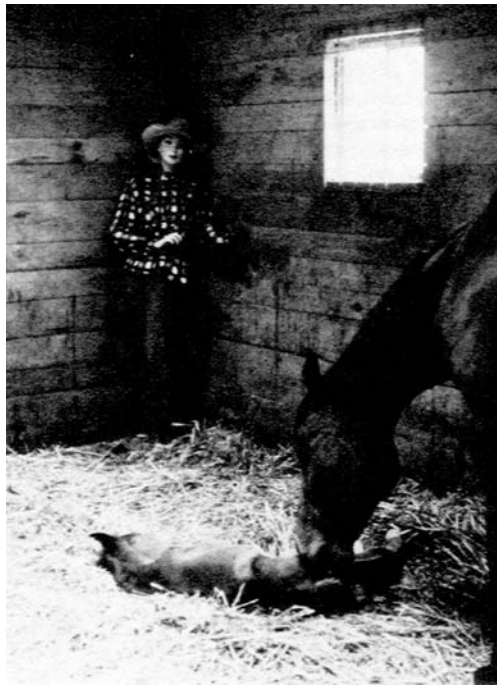


Figure 24.1: Mannequin used to provide newborn foals with a type of passive human socialization. (Waring 1970b)

A similar halter leading session was conducted the second day postpartum. Following the second session, the foals were neither led nor extensively human handled until three months of age. At three months of age, all six foals were haltered and led outdoors.

The comparative responses of the foals during the test sessions are shown in Table 24.1. During the first halter session, difficulty was encountered primarily with foal V, the individual that lacked actual human interaction. During the second session foals I, III, and V were difficult to halter; yet leading was successful with each of the five foals.

Table 24.1: Treatment and Comparative Responses of Six Foals to Various Types of Early Human Socialization

Type of Early Experience:

- (a) Active Handling Foals I and II were separated from dams and human fondled from 5 to 70 minutes postpartum
- (b) Passive Foal III received passive human exposure during hour 1 to 6; foal IV was bottle fed at hour 5 and 6
- (c) Mannequin Foal IV with mannequin from birth until hour 83; foal V, until hour 40; and foal VI, until hour 84

Responses Scored During Haltering and Leading	Responses of Foals*																	
	Day 1					Day 2					Day 90							
	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V	VI		
(a) Avoided stationary human	o	o	o	o	o	+	o	+	o	o								
(b) Objected to being haltered	o	o	o	+	+	+	o	+	o	+	+	+	+	++	+	++		
(c) Objected to walking with handler	o	o	o	o	+	o	o	o	o	o	o	+	+	++	+	+		
(d) Tended to back or bolt while on lead line	+	o	o	o	+	o	o	+	o	o	+	+	+	+	++	++		
(e) Tended to rear and fall	o	o	o	o	o	o	o	o	o	o	o	++	++	+	++	o		
(f) Objected to handler's directions	o	o	o	o	+	o	o	o	o	o	o	+	+	++	+	+		
(g) Uneasy at end of session	o	o	o	o	+	o	o	o	o	o	+	++	++	++	++	++		

*Responses scored as follows: o = no clear response, + = response overt, and ++ = response strongly overt.

During the session at three months of age, all foals objected to being haltered. Only foal I was tractable; foals II-V remained obstinate and objected to handling throughout the session. Foal VI, which was handled for the first time, acted fearful and confused yet did not show the same tenacity shown by foals II-V.

It is difficult to separate the effects of early human interaction from such factors as heritable tendencies, maternal influences, or prior experiences resulting from management procedures inadvertently unique to each mare and foal. Nevertheless, human socialization both active and passive seems to have an effect on newborn foals. We were interested to observe after the first halter session that foal II, after release in a paddock with the mare, soon returned to the vicinity of the handler and slept in lateral recumbency within 2 m of him. At the second session, foal III after release in the paddock followed behind the handler until herded away by the mare.

A foal's working relationship with the handler at the first halter session seemed dependent upon the degree of previous human exposure. The more handled foals performed better. By the second session, initial avoidance of the handler was appearing in foals without some form of continued exposure to a human form; yet once haltered all the foals were manageable. When human socialization was discontinued for three months, the advantage of early human interaction diminished. The quality as well as quantity of socialization during a sensitive period are both important to establish long-term associations.

The foals we have human handled during the early hours after parturition have not had their relationship with the mare greatly disrupted. However, compared to unhandled foals, the handled foals quickly habituated fear responses, were bolder, and exhibited more exploratory behavior. They left their mother's side more readily and to greater distances when first turned outdoors, approached other organisms, and showed more self-confidence. These behavioral differences characterized these foals as they continue to develop. Such behavior caused each mare to spend more time following her foal and herding it away from contacts with others. Unhandled foals were more reluctant to leave the side of their mother. Early-handled foals were, therefore, subject to more dangers resulting from their zealous curiosity and diminished inhibition.

One advantage of establishing the early foal-human relationship is the ease the newborn foal shows toward handling. Such a foal is little stressed. A newborn can be extensively handled with minimal effort by the handler and learns that human contact with its feet, ears, mouth, and elsewhere can

occur without harm. Furthermore, communication readily develops and training can progress effectively.

During early handling it is physically easy to teach a neonatal foal to relax upon restraint. To establish such training, the foal is repeatedly restrained (Figure 24.2) and subsequently released only upon its relaxation. Such learned relaxation can be valuable when later in life the horse becomes entangled accidentally in wire, equipment, or other hazard. It will tend to await assistance without struggling.

While investigating early experience, we found as human-socialized foals develop they tend to treat human handlers more and more as conspecifics and peers. Conspecific-oriented play and aggression of foals can be dangerous to a handler. Although similar conspecific-like activity exists in a dog-human relationship (Fox 1965), little danger occurs to the handler because of the relative gentleness of the behaviors and small size of the pup. As a foal develops, it is not readily subjugated by a handler merely because of prior human socialization. The handler's dominance must be re-exerted, at least with juveniles, at nearly every session.

Others have begun to test the merits of early handling using the scientific method. Mal and McCall (1996) divided ten foals into two groups. The early-handled group (EH) got 10 min of handling 5 days weekly from 24 h after birth until 42 days of age, then they were not handled until tested at 85 days. The late-handled foals (LH) were not handled until 43 days, then they were given 10 min of handling 5 days weekly to 84 days of age.



Figure 24.2: Restraining technique useful on a newborn foal.

At 85 days of age, each foal was subjected to a 10-min halter leading test for 5 consecutive days. Early handling increased foal performance on the halter leading test. Compared to LH foals, EH foals took less time ($P<0.05$) to take an initial step forward, to take 5 consecutive steps forward, and to travel 20 m. Examiners also gave EH foals more desirable test ratings than LH foals ($P<0.01$). Heird et al. (1981) found that handled horses scored higher on learning tests than individuals not handled in the first year of development.

Although more research is needed on early experience and human socialization, it appears early handling provides a means to develop a foal with certain traits, such as an ability to more readily control fear responses, habituate promptly to new situations, exhibit self-confidence and tractability, and interact with its surroundings. The desirability of developing a horse with such characteristics must be evaluated by each horse owner to best coincide with the future utility planned for the individual horse. Early handling and human socialization can begin the process of training in a foal and commence its lifetime of learning.

Training

One of the needs of the horse industry is for a reliable measure of the trainability of horses before considerable time and expense are devoted to an individual. It is apparent that individual differences do occur; some horses seem to have more potential than others. Heredity is involved (Mathes 1993; Houtp and Kusunose 2000). McCann et al. (1988a) and Wolff et al. (1997) developed tests for emotionality; Mackenzie and Thiboutot (1997) tested stimulus reactivity; Visser (2002) tested personality traits. To get a consensus evaluation about a horse from several trainers or to objectively determine trainability will likely be as difficult as Anderson et al. (1999) found to behaviorally assess the utility of horses in therapeutic riding programs. Opinions vary about training and the issues are complex. Training is an art that adjusts to the individual horse, its past experiences, its responsiveness to the trainer, its ability to remember, and other factors.

Training Environment

A suitable environment for training is important. Progress normally occurs most effectively in situations where fear responses and distracting stimuli are minimal, and where correct responses can be best ensured. A round pen

with high plank sides is such an environment. Once fundamentals are learned the horse can be further trained in other environments.

When seeking a new response, it is wise to structure the situation to facilitate the correct response rather than provide options for undesirable responses. A round pen or an arena, for example, reduces the risk that a horse will get out of control. Aids such as a martingale, a barrier, a corner, a curved turn, or an assistant can be used effectively to facilitate correct responses and curtail unwanted responses. Since horses tend to repeat previous responses, a special effort to have the response correct the first time is worth a few extra precautions.

Habituation to the environmental situation can be an important first step in a training program. The horse is allowed to adapt to the surroundings through repeated or continuous exposure to the fear-inducing or distracting stimuli. For example, a horse may require a period of getting accustomed to a handler or to various pieces of equipment before the individual is attentive to further training. A habituation procedure used by some horse handlers is sacking out, where the inexperienced horse is rubbed and contacted repeatedly with a cloth or saddle blanket before placing anything on the horse's back, such as a saddle.

Fundamentals of Training

An effective trainer knows not only the behavior of horses in general but also the specific traits of the horse being trained. Inherited traits as well as those acquired through prior experience will enhance or hinder training. Sometimes traits frustrating to one trainer will be used to advantage by another. Some horses learn faster than others and to more advanced levels. Athletic abilities also vary as do emotionality, attentiveness, and sensitivity to signals from the handler. Training should follow a systematic plan of building upon some traits and modifying others. Along the way, adjustments in the plan will be necessary to compensate for the horse's abilities and progress.

Early in the training program, trainers commonly learn about the horse's prior experiences plus understand its likes and dislikes, its responsiveness, and temperament. Trainers often take time to get acquainted with the horse as an individual and allow the horse to know them. They watch the horse and talk to it in a soothing manner. Whenever possible they progress to close body contact where the horse can smell and nuzzle them and they can stroke and rub the horse on the neck, withers, and face. Some handlers

favor the use of special sounds or tactile procedures for these sessions. The aim is to gain the horse's trust and get it to relax.

Training often builds upon existing stimulus-response relationships. For example, innate tendencies to move away from some stimuli and avoid others can be used effectively to develop new stimulus-response associations. Thus, while free schooling in a round pen or longeing a horse, a handler can initially use the position of his/her body to induce such responses as forward locomotion or stopping. Based on the innate flight response (see Chapter 3), closing in on the horse from behind will cause the horse to move forward. If the handler then shifts so the horse moves progressively closer to the handler, the horse will be induced to stop. A longe whip can be used to extend the trainer's body in front of or behind the horse without need for much change in actual location of the trainer. Commands to move forward or to stop can be paired during training with the already effective stimuli and the horse will learn to respond to the appropriate command (tactile, visual, or acoustical signal). Commands should immediately precede the already effective stimuli during the paired conditioning trials.

Commands should be specific for each response desired and given in a manner the horse can clearly discriminate from other signals. Walking, stopping, and turning are commonly taught before advancing to faster gaits and more complex maneuvers. Many trainers prefer to longe or ground-drive their horses before advancing to training under saddle.

Progressing gradually and sequentially from basic familiar activities to the more difficult facilitates understanding between horse and handler (cf. Potter and Yeates 1990). The horse becomes attuned to signals emanating from the handler, and the handler can more easily learn the capabilities of the horse. Multiple training sessions, shaping, and the phenomenon of learning set formation can be used to advance otherwise difficult training.

Successful horse training is often contingent upon reward or punishment and its timely application. Reinforcement (both positive and negative) increases the probability of the performance of a behavior. Reinforcements can be primary reinforcement (e.g., natural rewards such as food) or secondary reinforcement (learned by association with primary reinforcement), such as the words "Good Boy." A horse tends to increase or repeat behaviors done just prior to positive reinforcement, such as a nibble of carrot for coming to a handler when called. Negative reinforcement is an aversive event that increases the probability the animal will respond to avoid or escape subsequent negative reinforcement. Typically negative reinforcement is applied until the animal does the desired behavior; thus, the horse

feels relief when the handler ceases the negative reinforcement. By ceasing the negative reinforcement, in effect the horse is rewarded. Bit pressure and prodding of spurs are examples of negative reinforcement; experienced horses learn to minimize the degree of their application by responding effectively. Punishment is different from negative reinforcement; punishment is applied subsequent to a horse's response in order to decrease the frequency of that type of response (Voith 1986; McCall 1990).

To be effective in establishing or squelching a particular stimulus-response relationship, the presentation of reward or punishment should immediately follow the response. This is especially important with punishment since the horse will associate the reprimand with whatever it has just done. If some correct response occurs just as punishment is administered, the horse will be reluctant to give the correct response again. Likewise, reward following misbehavior will tend to establish that behavior. The horse will tend to do the misbehavior again to get rewarded. Thus, undesirable behavior is often brought on by the untimely and injudicious use of reward as well as punishment (see Slade 1980; Mills and Nankervis 1999).

Horse training typically involves a mixture of reward and punishment. A reassuring voice and gentle stroking with a hand are examples of rewards; release from unpleasant situations can be rewarding as well. Punishment includes a castigating tap with a whip or a chiding voice. Over the centuries, horse trainers have varied greatly how and to what degree they have used positive reinforcement, negative reinforcement, and punishment. Often negative stimuli have been emphasized, using such techniques as avoidance conditioning, escape conditioning, or punishment (Fiske 1979). With the latter, the horse is reprimanded for making an inappropriate response. In escape conditioning, the horse receives a noxious stimulus (e.g., bit pressure) and must learn how to respond to eliminate the stimulus. In avoidance conditioning, the horse learns that if it responds appropriately to a signal (e.g., a leg cue) it will avoid receiving an aversive stimulus that would otherwise occur (e.g., spur contact).

With positive reinforcement training, reinforcement for every correct response is usually done during initial training, but once learning has occurred an intermittent reinforcement schedule is commonly applied. Performance is less likely to extinguish under an intermittent reinforcement schedule than if the organism were suddenly to get no reinforcement after having gotten rewarded previously on every occasion. Throughout a training session, positive reinforcement should remain highly desirable to the horse; satiation to rewards should be prevented. Carl Pitts (personal

communication) quickly established verbal commands, riding, jumping, and assertive behavior (where the horse was trained to be more aggressive to other horses in a pasture) using exclusively a positive reinforcement system with a small dose of dilute maple syrup remotely supplied to the mouth of a 2-year-old naive gelding.

The technique of shaping can be used to guide a horse into a proper response. With this method the individual is reinforced for successive approximations until the end response is achieved. A general response is first accepted as an approximation and is rewarded, the next reinforcement is given immediately after a better approximation, and so on until the horse does the sought-after response.

Horse handlers can help build the confidence of horses. As mentioned above, this can be done initially with early handling and human socialization of the neonate. Handling and training can begin at birth, be maintained continually, or occur later. Regardless of when handling and training begin, confidence building can be done by safely exposing the horse to a variety of situations and experiences. When fear is shown toward some harmless object, the handler can help the horse by stopping, turning the horse toward the object, and encouraging investigation from a distance; as the horse develops a better understanding of the object and relaxes, some degree of approach can be encouraged. The aim is to reduce the animal's flight distance as well as its approach distance (see Chapter 3). Once it is more experienced, the horse should learn the handler may require the horse to pass suspicious objects using a controlled gait. To accomplish this, the handler should repeatedly guide the horse past suspicious objects at various safe distances, thus demonstrating to the horse that it is possible to pass without having to confront objects directly.

When undesirable behavior appears in the handling routine of a horse, treatment early can usually alter the undesirable trait more easily than waiting until the behavior is well established through habit. In some cases, simply not reinforcing a response will cause it to diminish through the process called extinction. Unfortunately most undesirable behaviors are not so easily eliminated. For example, vices brought on by boredom seem to be self reinforcing. The underlying cause of misbehavior should be determined and corrected, as warranted. Lack of companionship, fear, excess energy due to insufficient exercise, improper handling, illness, trauma, or nutritional deficiencies may be involved. Correct diagnosis of the situation will forestall making matters worse. A new environmental setting is often helpful. Punishment is not an effective way to treat fear-induced responses, such as

balking at a stream crossing or kicking when a leg is handled. Harsh treatment may temporarily inhibit the trait but will likely compound the real problem (Voith 1979a). Treatment must involve eliminating the fear.

Modifying an undesirable behavior can follow the same principles used in training. Usually the horse must learn that alternative responses are more appropriate, and the trainer works toward achieving specific alternatives through conditioning techniques using reinforcement (especially positive reinforcement).

Desensitization and flooding are two techniques employed to modify the behavior of horses exhibiting excessive fear. With desensitization, the horse is first induced to relax then gradually tiny increments of the fear-inducing situation are introduced. Relaxation is again achieved and maintained before additional increments are introduced. If all goes well, eventually the full fear-inducing situation can be presented and the horse will no longer exhibit the excessive fear shown days or months earlier before desensitization sessions began. The technique requires time and patience. Flooding relies on a horse reducing its fear response through the process of habituation. It is not suitable for all situations. Certainly, the horse must not be subjected to harm and should not be able to escape from the treatment area. The horse is then exposed continually or repeatedly to the fear-inducing situation or a facsimile. The aim is for the excessive fright to wane when the horse learns that no harm occurs upon repeated exposure to the stimulus situation. To restore calm in the horse for the long term, the procedures of desensitization or flooding usually must be repeated—especially in more than one location.

Counterconditioning is a technique employed to replace an undesirable behavior with one that is favorable. The trainer first perfects a response (e.g., standing) that is not compatible with the misbehavior (e.g., moving away). By repeated trials, the horse learns to readily respond to the cue (e.g., the word “stand”) given by the trainer to do the favorable response and that it will only get rewarded if it does it well. Progress is made on this stimulus-response relationship in different locations and under varying situations. Reinforcement on every occasion is gradually shifted to intermittent reinforcement. Eventually a horse that previously was exhibiting an undesirable behavior (e.g., restlessly moving away) can be induced to exhibit a favorable behavior (e.g., stand still in the presence of a human who says “stand”). To resolve behavior problems, often one technique is combined with another, such as using desensitization plus counterconditioning.

Patience and persistence are required of the handler in any training procedure; these virtues are indispensable when correcting behavior problems since hundreds of trials, if not thousands, may be required. Short cuts may not be available or may instead be considered too risky to pursue. A calm, steady, confident, and understanding demeanor is helpful. Trainers rarely succeed who do not have confidence in their ability, who lose emotional control of themselves or the horse, or who allow the horse to assume the alpha dominance rank in their relationship.

Attentive and responsive horses learn most efficiently, thus trainers usually try to maintain motivation and avoid boredom as well as overwork. Lessons commonly range from 5 to 15 minutes, rarely more than 30 minutes. Several brief lessons will normally achieve more than a single long session. Habits form and anticipations occur when sessions are routine.

Ending a training session should be viewed by the handler as a form of positive reinforcement. Thus, it is important to end following a set of correct responses by the horse. To avoid rewarding undesirable behavior when a horse has misbehaved or has not been able to achieve a new task, it may be necessary to return to previously learned activity before stopping a handling session. For this reason, some horse owners find it worthwhile to reschool their horse at least briefly following handling by another person.

—Restraint—

Casting or the severe technique of choking down a horse has occasionally been used on wild, intractable horses to permit flooding the individual with human handling. For example, Catlin (1857) observed American Indians successfully subjugated feral horses in a single session by physically casting a horse to a recumbent position and then progressively handling the individual (especially around the head) before allowing it to stand. Succinylcholine chloride has been used in a similar way to cast unruly, aggressive horses and permit a barrage of handling while the horse is immobilized but fully conscious of stimulation (Miller 1966). The overt objection the unruly horse has toward human contact before restraint and handling is substantially diminished after such extreme treatment. This type of treatment causes the horse to become submissive to the handler. Follow-up handling is used to maintain the willingness of the horse to permit human contact and manipulation.

A variant of the above casting techniques and also used to calm an unruly horse is the use of a specially-designed box (slightly longer and wider than

the horse) into which the horse is guided. Only the head projects from an opening at the far end of the box as the doors are closed. Wheat is then added to the box from above and is allowed to cover the legs, barrel, and back of the horse. The horse is restrained in this immobilized state for 20 to 30 min, while the head is stroked and gently contacted. Following the treatment period, the grain is promptly removed through the slotted flooring. Once the horse is released from the wheat pressure box the calming effect lasts for about 30 min; during this period, the horse is given extensive but gentle rubbing and contact over all its body to demonstrate to the animal that no harm results from human contact.

Besides their use to mellow a fractious horse, physical and chemical restraints are usually used to reduce risk (i) to humans, (i) to the horse itself, or (iii) to other horses while some momentary procedure is carried out. In most instances, training is neither intended nor deemed a practicable alternative to assure safety and reduce the likelihood of unwanted movement. Restraint is an attempt to counteract the horse's innate tendency to take flight or to exhibit aggressive responses during contact. Numerous techniques for restraint have been devised (e.g., see Leahy and Barrow 1953; Fraser 1967; Catcott and Smithcors 1972; Brownlow and Hutchins 1991; Rose and Wright 1991; Fowler 1995).

Oftentimes little restraint is applied to a horse that has learned through prior experience to accept handling of various kinds. Yet even a well-mannered horse may suddenly show a vigorous agonistic response when frightened or in pain. Precautionary measures can be valuable. Nevertheless, applying a method of restraint more severe than is necessary for a particular procedure is undesirable; the horse may object more to the restraint than to the procedure itself. Since the apparatus and manipulations used in restraint can themselves cause uneasiness in a horse, it is useful to conduct practice sessions where the concurrent stimuli are gradually and repeatedly presented to the horse to habituate fear responses.

Physical restraint once applied should be held firmly and with confidence. Horses under weak and inadequate control tend to become increasingly restless and unruly. Occasionally a horse learns to resist one type of restraint and a new method must be employed. Hand holding of restraining apparatus is commonly practiced to permit rapid release in an emergency. Quick-release fittings, operable even under tension, should be used whenever fixed lines are used. The surroundings, including the substrate, should be chosen and prepared to facilitate safety, the pending restraint, and the required procedures.

At the minimum, the head is normally restrained if no more than with a hand or line to a halter (head collar). Some handlers additionally apply a chain shank of a halter line either over the muzzle, under the jaw, through the mouth, or over the upper gums (gingiva) to gain greater control (Vaughan 1972; Rose and Wright 1991). Bits and other pieces of horse handling equipment can function to aid restraint.

For procedures lasting less than 10 min, the twitch (Figure 24.3) is commonly applied to cause head restraint and body immobility. Grasping an ear or a handful of skin at or behind the shoulder can, in some cases, cause similar immobility. Many commercial and homemade twitches are used with varying degrees of effectiveness. The principle of each is to apply pressure to the sensory nerves of the lip, typically the upper lip near the incisor teeth. Before the endorphin-enkephalin-dynorphin system was discovered, it was thought the discomfort of the twitch diverted the horse's attention while treatment was conducted elsewhere on the horse's body. However, Lagerweij et al. (1984) found twitch application elevated β -endorphin concentration in the plasma. The heart rate in twitched horses increased by 8 percent compared to a 22 percent increase in horses not twitched. The morphine antagonist naloxone prevented bradycardia in twitched horses, suggesting endorphins were responsible for the cardiac effect.



Figure 24.3: The twitch is one of the more commonly used methods of restraint.

The war bridle (or rope gag) is a simple and effective method of restraint when used prudently. A rope is passed over the poll and either over the upper gingiva (Figure 24.4) or around the lower jaw (Figure 24.5). Pull on the rope causes localized discomfort and likely an endorphin release which results in a general immobility response.

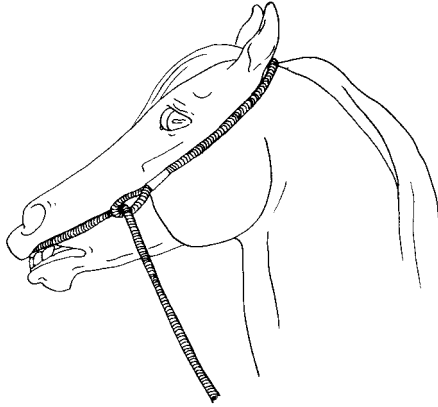


Figure 24.4: Variation of a war bridle where rope pressure is applied to the gingiva above the upper incisor teeth.

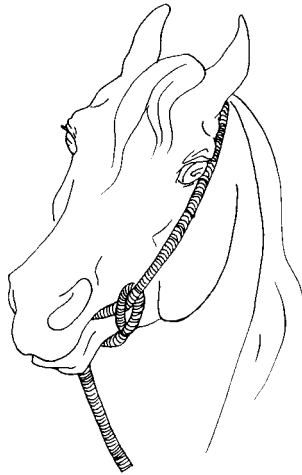


Figure 24.5: War bridle where constricting pressure occurs to the jaw as rope tension is increased.

Occasionally the head must be restrained from turning to lick a wound on the body or legs. A side stick (Figure 24.6) will prevent the horse from reaching its hindquarters but does allow grazing and foreleg contact. A cradle (Figure 24.7) will prevent a horse from reaching both the fore- and hindquarters.

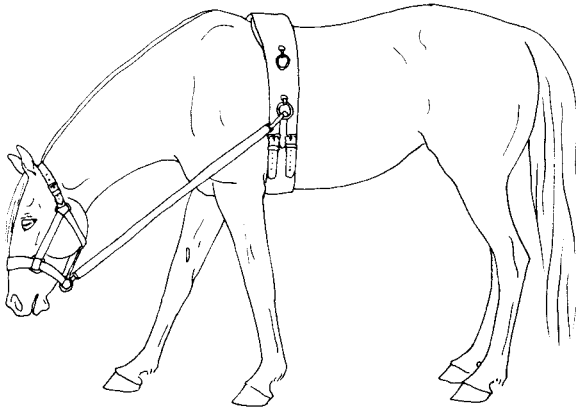


Figure 24.6: A rigid side stick can be used to prevent a horse from licking or biting at wounds on the hindquarters.

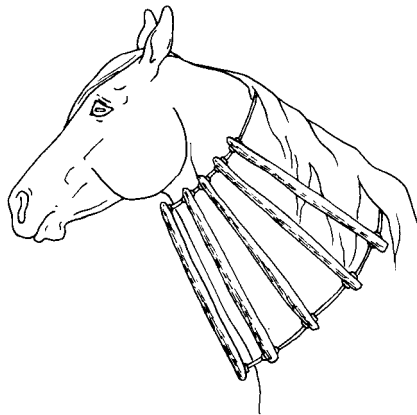


Figure 24.7: A cradle limits turning as well as lowering of the neck. It is used to prevent a horse from gaining access to wounds on its body or legs.
(Adapted from Leahy and Barrow 1953)

Various kinds of hobbles are used to restrict leg movement. For example, a strap or rope may be used to bind a single foreleg bent at the knee (Figure 24.8). Or both forelegs may be fastened together with a short strand of webbing or leather encircling each pastern. Breeding hobbles limiting backward movement of the hindlegs are used to restrain a mare from kicking during breeding or gynecological procedures. Such hobbles can be fashioned from rope, leather, or webbing; some, such as the one in Figure 24.9, permit walking yet restrict kicking.

With reasonably manageable horses, manual restraint of a fore- or hindleg can be performed by lifting and holding the pastern or cannon. For an injection into a lower hindleg, manual restraint can be achieved by lifting the leg from the opposite side and directing it beneath the belly and forward of the supporting hindleg.

The tail can also be used to aid restraint. Manual displacement of the tail over the horse's back or to one side is often effective to discourage kicking and permit rectal or urogenital examination. A rope tied to the tail at the end of the last coccygeal vertebra permits a solid tail attachment that can be used for hindquarter restraint or even to help support a hindleg for treatment. In the latter instance, the rope is passed through a strap circling the hind pastern then passed over the horse's back to an assistant standing on the opposite side of the horse (Figure 24.10).

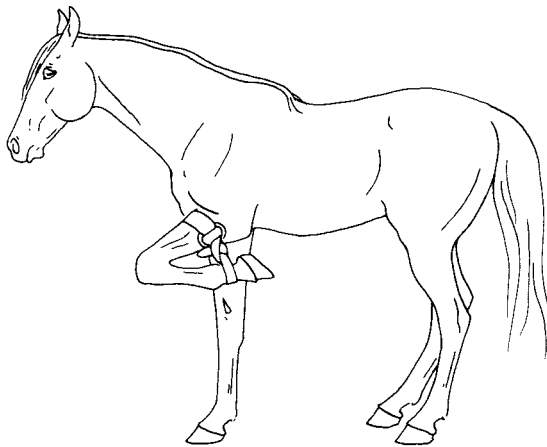


Figure 24.8: Stirrup-strap hobble used to restrict locomotion while treating a horse. (Adapted from Leahy and Barrow 1953)

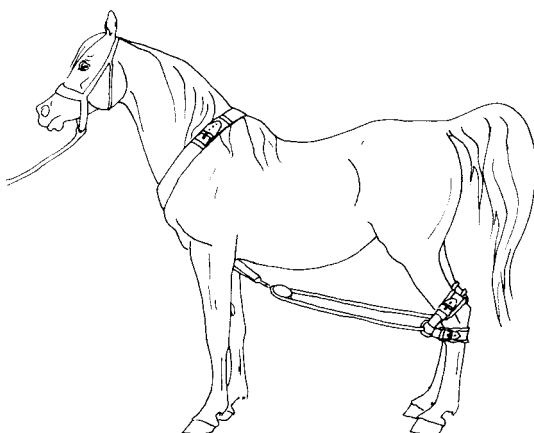


Figure 24.9: Breeding hobble used on mares to prevent kicking; nevertheless, with this design, walking is possible.

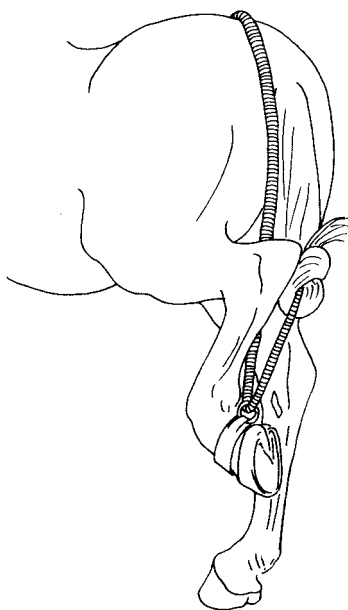


Figure 24.10: Tail-rope technique to hold up a hindleg for treatment.

Cross-ties (fixed lines attached to each side of the halter) are commonly used to restrict the movement of a horse during grooming, saddling, and standard management procedures.

Stocks are devices usually made of wood or metal that are designed to restrict lateral as well as forward and backward movement of a standing horse while permitting access for medical treatment. For example, two rows of posts may be used, or a set of crossbars supported by corner posts. The length and width of the space within a stock is designed to just fit the length and width of the horse.

Slings are normally used to help support a horse in a standing position. To avoid physiological complications, the horse should be able to support its own weight at least partially. Occasionally a sling is used to temporarily assist a horse to its feet. A broad belly band with an additional band at the chest, another around the hindquarters, and all linked to a single support from above can form a satisfactory sling (Vaughan 1972).

Skittish horses can oftentimes be quieted by covering their eyes with blinders to restrict or prevent visual stimuli.

Occasionally it is necessary to force a horse into a recumbent position. A pony or small horse can be cast manually by standing on one side of the animal, reaching over the back for the halter and tail (passed forward by an assistant through the groin to the opposite flank), then by turning the head backward and pulling upward with both hands the animal is brought down against the handlers legs. Casting harnesses are usually used for large horses. Various designs exist and are commonly made of rope, leather, or webbing. To accomplish casting, the hindlegs are drawn under the horse by pulling on side lines. In the double side-line casting harness (Figure 24.11), one person pulls the rope on one side, another simultaneously pulls the other side-line in the opposite direction, and a third person holds the halter rope to guide the fall and to restrain the head once the horse is prone. Subsequently the legs can be bound in a flexed or in an extended position.

Chemical agents are now commonly used to cast horses (see Brownlow and Hutchins 1991). Caution is taken to use a halter and line to prevent the horse from falling backward into a wall or against some stationary object. In some cases, a drug that causes muscle relaxation but without loss of consciousness (e.g., succinylcholine) is used. At other times one or a combination of anesthetics may be administered.

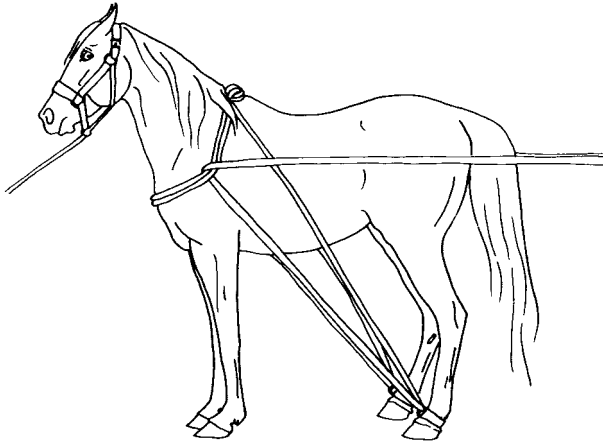


Figure 24.11: Double side-line casting harness used to force a horse to recumbency by pulling the side lines simultaneously in opposite directions. (Adapted from Leahy and Barrow 1953)

Under the influence of a general anesthetic, loss of the ability to stand occurs in the stage of anesthesia called Stage II. This sometimes follows a period of unrest or even excitement, depending on the temperament of the horse, the environmental situation, as well as the drug used. Stimulation must be kept minimal even in Stage II to avoid struggling and excitement. Reflexes in this stage become exaggerated, nystagmus often occurs (sometimes accompanied by blinking), pupils dilate, the ears may twitch, muscle tone is increased, and breathing is irregular. As anesthesia advances, the signs of Stage III (surgical anesthesia) are seen beginning at Plane 1. The horse no longer responds to painful stimuli. Pupils become constricted, except with a few drugs. The palpebral, anal, and corneal reflexes are present in light surgical anesthesia (Plane 1) but become weak and absent as anesthesia becomes deeper. Breathing and heart beat become steady, and muscle relaxation occurs. In the deepest plane (Plane 4) of surgical anesthesia, signaled by pupil dilation and dribbling of urine, both respiration and cardiovascular function are severely depressed; thus risk of death is high if the animal is not soon returned to a lighter level of anesthesia. This deep level of anesthesia is therefore avoided.

The duration and nature of recovery from anesthesia depends on the drugs used. Precautions should be taken during recovery to protect the horse from

injury due to uncoordinated movements. Struggling is more frequent in animals that have not received preanesthetic tranquilizers and in animals excessively restrained or stimulated during recovery (Gabel and Jones 1972).

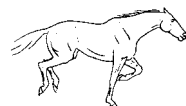
Food and water should be withheld from horses recovering from general anesthesia, or when under other forms of chemical restraint, until full recovery occurs.

Tranquilizers are used to control nervousness and hyperexcitability in horses. The treated individuals become drowsy and less responsive to their surroundings; nevertheless, when subjected to strong or unusual stimulation, especially pain, they may react more violently than they would without a tranquilizer. Besides calming a horse, tranquilizers are sometimes used to induce prolapsing of the penis to permit cleaning and examination (Gabel 1972).

Sedatives are also used to quiet horses. These compounds cause a sleep-like state, but not necessarily recumbency, and usually reduce the horse's responsiveness to painful stimuli. Sedatives commonly show their effect more rapidly than tranquilizers. Sedatives or tranquilizers are commonly used as preanesthetic medication. Narcotic analgesic compounds tend to stimulate locomotor activity in horses (Combie et al. 1979) and are seldom used when restraint or quiescence is desired.

The effectiveness of chemical compounds for restraint is affected by such factors as dosage, manner of administration, and the physiological and psychological state of the animal. Emergency medical procedures are sometimes required to counteract unforeseen complications while using drugs. Without adequate knowledge and safeguards, use of chemical agents is not advised.

25 Behavioral Indicators Relevant to Health and Well-Being



Behavior can be a valuable tool when judging the health and well-being of a horse. When a horse is healthy and stress free, its condition tends to show in the way it acts; previous chapters have emphasized these behavior patterns. But when things are not right, it does not always take a medical exam to first detect symptoms. Horse problems typically have a behavioral component, whether those problems are physical, physiological, or psychological. Thus behavioral symptoms can be used as a signal that there has been an alteration in the horse that may need medical attention or other special care. A change in behavior is often determined by comparing observed patterns to traits shown previously by the individual or by most horses of the same age and gender.

Behavioral symptoms include atypical postures and facial expressions, decreased ability to orient or to move in a normal manner, apparent loss in perception, poor maintenance activities, altered social interactions, and excessive agonistic behavior (Figure 25.1). In some cases, only a shift in intensity, frequency of occurrence, or rhythmicity is symptomatic. At other times, entirely new behaviors occur. The Appendix of this book cites and categorizes many equine behavioral symptoms and the possible problems they may indicate, whether they are due to dysfunction, trauma, nutrition, allergies, toxins, parasites, infections, handling, or management conditions (cf. Colahan et al. 1991).

Changes in Expression and Posture

Expression and posture changes, indicative of a variety of maladies, can involve not only the head and neck but also the rest of the body. Thus an abnormal angle or atypical movement of the legs, tail, back, neck, or head should be noted with concern. Peculiarities in the way the ears, eyes, eyelids, lips, tongue, lower jaw, and nostrils are positioned or moved may signal problems, such as localized irritation or neural damage involving branches of the cranial nerves.

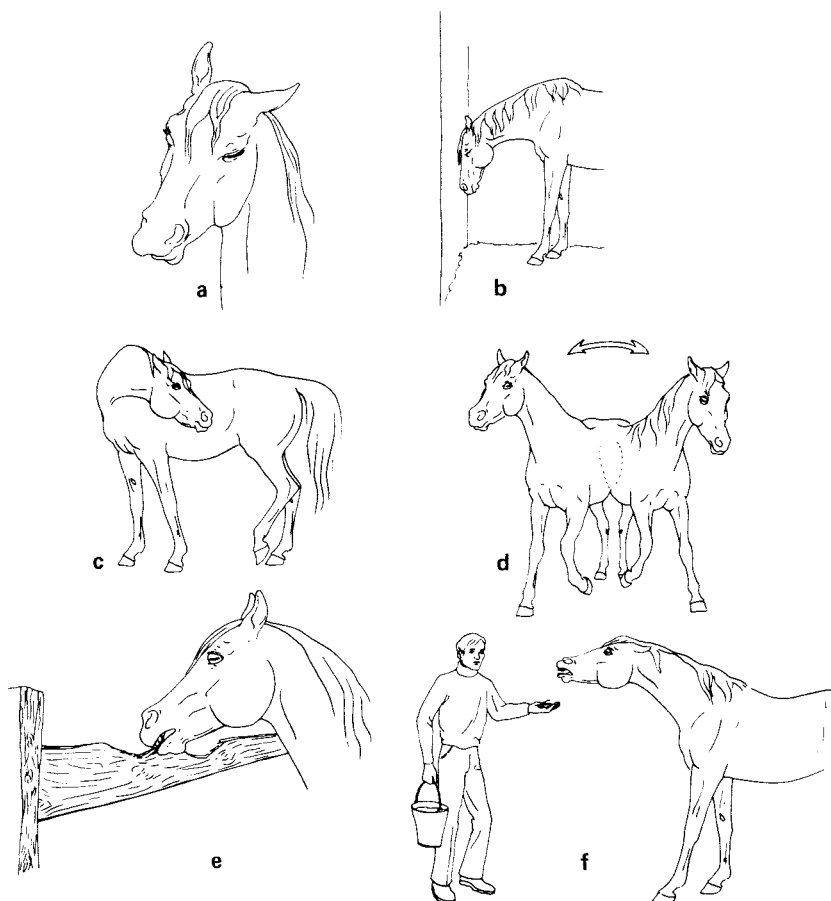


Figure 25.1: Some behavioral symptoms: (a) change in facial expression (damage to left facial nerve), (b) change in posture or orientation (head press against wall), (c) sign of discomfort (looking at abdomen), (d) stereotyped movement (weaving), (e) pica (wood chewing), (f) change in temperament or social behavior (abnormal aggression).

Some expressions signal pain (e.g., see Walser 1965; Fraser 1969). For example, discomfort in the abdomen is often indicated by pawing, rolling, staring at flanks, groaning, frequent lying down and getting up, bumping the belly by lifting a hindleg, or sitting dog-like with forelegs extended supporting the forequarters.

Some ailments exhibit characteristic postures or expressions while others vary in their effects on the behavior of individuals. For example, tetanus typically causes a rigid, spread-leg stance with head and tail

extended; encephalomyelitis may be signaled by an abnormal stance, drowsiness with yawning, drooping lower lip, or oscillations of the eyes (Byrne 1972; Knight 1972; Siegmund 1973; Aiello 1998).

Changes in Perception and Orientation

Some ailments cause changes in the perception or orientation of horses (see Appendix). For example, certain toxins and diseases such as periodic ophthalmia or encephalomyelitis can impair vision and can cause disorientation. The visually impaired individual typically fails to investigate new objects and may collide with them; the horse may stumble, or exhibit a cautious high-stepping gait, or when led may move the ears excessively. Shying and other forms of fear may at times be due to impaired vision. Nerve damage can cause not only loss of vision but also hearing and olfactory impairment, loss of reflexes, and localized anesthesia. Circling, vertigo, and aimless wandering are behaviors that result from any of a variety of problems such as poisoning, brain lesions, and infections that impair the horse's orientation (Siegmund 1973; Aiello 1998).

Changes in Motor Coordination

Motor coordination symptoms appear with many types of problems. Abnormalities of locomotion (such as staggering, stiffness, and lameness) can result from toxins, infections, and a variety of anatomical or physiological problems with the legs and feet (cf. Rooney 1981). Tremors and clonic muscle spasms (rhythmic contraction) can occur with ailments such as paspalum fungus poisoning, epilepsy, rabies, and the neonatal maladjustment syndrome; tonic spasms (continuous tension) appear, for example, in tetanus, meningeal disease, mucormycosis, eclampsia, and with certain poisons such as lead or strychnine (e.g., see Siegmund 1973).

Incoordination, lethargy, and weakness appear with many ailments, including heat exhaustion, respiratory disease, cirrhosis of the liver, and severe hypoglycemia. In some cases, horses show a reluctance to move and may have paralysis. Damage may have occurred to peripheral nerves or involve dysfunction of central nervous tissue. Yet a horse suffering a ruptured stomach, laminitis, azoturia, or exhibiting an agonistic response to a handler may also refuse to move. Horses with West Nile virus encephalomyelitis may initially show degrees of lameness, ataxia in all four limbs, marked hypermetria, and recumbency (Snook et al. 2001).

Discomfort in the shoulder, pelvis, or limbs is manifested as lameness. Lameness frequently is signaled by a change in the way the head and neck move during locomotion. Abnormal head bobbing appears. When a foreleg is affected, the head and neck drop when the healthy foot lands and raises as the painful foot makes contact. In hindleg lameness, the opposite pattern occurs; the head raises when the sound foot lands and drops when the lame leg makes contact.

Changes in Maintenance Behavior

Symptoms of many maladies appear as changes in resting pattern, ingestive behavior, respiration, grooming, eliminative behavior, and other maintenance activities. Dental problems usually alter characteristics of chewing, whereas ailments of the pharynx or esophagus can affect swallowing and the interest of the horse in food or water. Stressful environments, discomfort, trace mineral imbalances, and contaminated food or water can affect ingestion patterns also. Coughing and alterations of the respiratory cycle, including nostril dilation, can result, for example, from infections, toxins, heat exhaustion, respiratory or esophageal obstruction, heaves or other respiratory ailments. Foals may lose the sucking reflex with various septicemias and bacteremias as well as with the neonatal maladjustment syndrome (Rossdale 1968b; Siegmund 1973; Aiello 1998).

Ailments can affect the way a horse conducts comfort behaviors and cares for itself. Skin ailments may cause excessive rubbing and result in open wounds. Grooming may be prolonged, unusually frequent, or neglected entirely. Rolling can be frequent in a horse experiencing abdominal pain. Ear parasites may cause frequent head shaking; yet other causes may include ocular disease, middle ear disorders, cranial nerve dysfunction, guttural pouch mycosis, dental osteitis, and vasomotor rhinitis (Lane and Mair 1987; McGorum and Dixon 1990; Madigan et al. 1995; Newton et al. 2000).

Colic appears with many ailments, such as with allergic reactions, toxins, ruptured bladder, scrotal hernia, parasitic infections, and a variety of gastrointestinal problems. It can also have a psychogenic basis (e.g., Murray and Crowell-Davis 1985). Calculi in the urinary system and cystitis affect urination patterns. Sweating occurs excessively with some ailments, such as gastritis, severe hypoglycemia, and allergic reactions; yet, sweating stops with salt deficiency and heat exhaustion.

Changes in Social Behavior

Some ailments noticeably alter social behavior of horses (see Appendix). For example, increased aggression characterizes rabies. Changes in sexual behavior can be caused by such factors as nutritional deficiencies and malfunction of the gonads. The tendency for horses to become solitary can appear in acute infections and toxicosis; solitary tendencies seem characteristic of locoweed poisoning and the maladjustment syndrome of foals. It is not unusual, however, for mares about to give birth to leave their social group to achieve temporary isolation.

Horses that as young foals are isolated for a prolonged period from other horses may show little desire for equine companionship later, especially if an alternate form of companionship was available during the isolation period. If a human or another species serves as foster parent and companion during a foal's otherwise isolated early life, social preferences tend to focus on members of the foster parent species rather than on horses (cf. Grzimek 1949a). Subsequently, when pastured with other horses, the individual with altered social development prior to weaning will tend to exhibit solitary tendencies when the foster species is not present. The foal's sensitive period for primary socialization is evident during the second hour postpartum (Waring 1970b); where the period ends is not known, but it greatly diminishes following the establishment a social bond to some organism as well as when fear of new objects develops in the early hours of age. Prolonged social contact over many days accentuates in foals the effect of primary socialization, thus social preferences become entrenched.

Appearance of Problem Behaviors

Sometimes, in what may seem to be a healthy horse, behavioral patterns appear that interfere with the utility, well-being, or esthetic value of the individual. These behaviors are sometimes called vices and include such behaviors as pica (chewing and ingestion of unnatural items), cribbing (Figure 25.2), weaving, self-mutilation, bucking, bolting, shying, and rearing (e.g., see Temple 1963; Ralston 1986; Houpt 1986; Beaver 1986; Boyd 1986; Brewer 1991). The behaviors are not without cause and can be symptoms that the horse is suffering, for example, from a dental problem, nutritional deficiency, parasitic infection, or is being housed or handled improperly. Unless the cause of the behavioral problem is corrected soon after the pattern appears, the behavioral trait may become a habit and persist. Temporary inhibition of the undesirable behavior can sometimes be achieved

with special equipment (e.g., a cribbing collar). However, treating only the symptoms may eventually lead to other problems unless the fomenting cause of the abnormality is also corrected.

When horses are removed from the open range as well as their normal social environment and when they no longer can spend much of their day foraging and expending energy seeking suitable resources, the likelihood is high that abnormal traits will appear. Feeding only concentrated foods further complicates the situation by eliminating the additional time animals normally occupy themselves with manipulating and ingesting food.

Confined horses with restless energy may begin stall walking, digging, weaving, wood chewing, cribbing, or kicking of the stall walls to relieve boredom or frustration. Varied environmental experiences, companionship, roughage diet, and regular program of exercise help reduce the occurrence of these behaviors. Returning problem horses to a pasture situation should be considered (Houpt 1981). The more a horse is confined the greater the tendency to exhibit abnormal behaviors (cf. McGreevy et al. 1995a).

Research on problem behaviors is providing interesting information. For example, Dodman et al. (1987; 1988) has shown how injection of an opioid antagonist can decrease stereotypic behaviors (such as cribbing). These investigators have noted sweetened grain rations increase cribbing frequency.

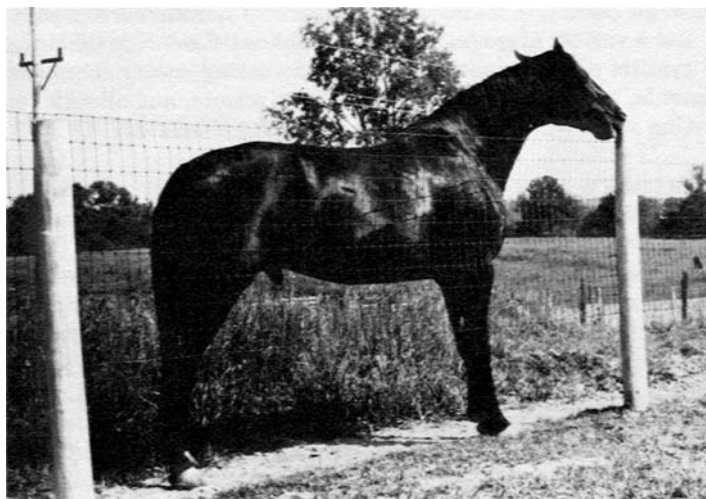


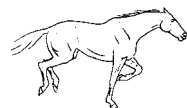
Figure 25.2: A cribbing horse pushing its upper incisors against a fence post. Uneven wear of the upper incisors is a common consequence of the repetitive activity of cribbing.

Further work has suggested a diet of high-quality hay with relatively little grain can reduce cribbing (Gillham et al. 1994) as well as self-mutilation (McClure et al. 1992; see also McDonnell 1993; Luescher 1993). Unlike formerly thought, McGreevy et al. (1995b) determined that windsucking (aerophagia) does not occur during cribbing. Sambraus and Radtke (1989) studied 27 known weavers and found this affliction was exhibited on the average 67 min per day; weaving oscillations per day ranged from 400 to 18,000 and occurred in bouts; bouts were often linked to ceratin environmental irritations. Cooper et al. (2000) found weaving was especially common prior to feeding plus prior to release onto pasture; weaving and excessive nodding could be decreased by increasing the number and location of openings of the stall. Krzak et al. (1991) noted wood chewing occurred primarily at night; a regular program of exercise reduced the occurrence.

Oftentimes sexual behavior problems can be reduced, if not eliminated, by proper nutrition or by careful regulation of sexual interactions. Anestrous mares frequently become cyclic with improved nutrition. A stallion used too frequently for breeding and one that experiences pain or other aversive events during coitus may develop impotence, avoid sexual interactions, or become unable to complete intromission with ejaculation. In some cases, ejaculation is inhibited only in certain situations, for example, by an artificial vagina but not during natural mating (Bielanski 1960). Behavioral inhibitions can often be reversed by correcting the cause and using conditioning techniques to re-establish libido, mounting, and successful intromission.

Disturbances during copulation which prevent ejaculation may induce excessive biting by the stallion. A stallion repeatedly affected appears to generalize and becomes unduly aggressive toward each mate. Tyler (1969) observed that stallions upon being turned out onto open range from winter confinement attempted to copulate with mares whether or not they exhibited estrus. Once a mare was selected, a stallion's pursuit was relentless. The stallions became increasingly aggressive and in some instances attacked young mares and mauled foals. The aggressiveness of the stallions eventually waned as the breeding season progressed and sexual behavior became oriented primarily toward mares in estrus. Stallions remaining on the range over the winter did not show the unusual aggression or the indiscriminate interest in mares.

Appendix



Variety of Equine Behavioral Symptoms and Possible Problems Indicated

Behavioral Symptom	Dysfunction and Trauma	Nutrition, Allergy, and Toxins	Parasites and Infections	Handling and Management
<i>Expressions and Postures</i>				
<i>Head:</i>				
Ear immobility	Facial nerve damage	—	—	—
Drooping ears	Hearing impairment	—	African horse sickness	Drug (depressant)
Rigid ears	—	—	Tetanus	Drug (stimulant)
Rapid ear movement while walking	Vision impairment	—	—	—
Oscillating eye/nystagmus	Vestibular system lesion	—	Encephalomyelitis	—
Diverging eye/s strabismus	Oculomotor nerve lesion	—	—	—
Staring/stupor	Discomfort, Cerebral edema	Senecio poisoning	—	Drug reaction
Looking at flanks	Abdominal discomfort	—	—	—
Nictitating membrane closure	—	—	Tetanus	—
Unilateral eyelid closure	—	—	Periodic ophthalmia (uveitis)	—
Facial paralysis	Facial nerve damage	—	Infection of guttural pouches	—
Grimace expression	—	Poisoning (yellow-star thistle, Russian knapweed)	—	—
Deviation of nose	Facial nerve damage	—	—	—
Drooping lower lip	—	—	Encephalomyelitis	—
Hypertonia of upper lip, Basal ganglion disease	—	—	—	—
hypotonia of lower lip	—	—	—	—
Curling of upper lip	—	Allergic reaction	—	—

Behavioral Symptom	Dysfunction and Trauma	Nutrition, Allergy, and Toxins	Parasites and Infections	Handling and Management
Tongue and lip tremors	Basal ganglion disease	—	—	—
Lolling of tongue	Stomatitis, Paralysis of tongue	—	—	—
Involuntary chewing, tongue flicking	—	Yellow-star thistle poisoning	—	—
Champing of jaws	Neonatal maladjustment syndrome	—	—	—
Grinding of teeth	Esophageal disorder	Poison hemlock poisoning	—	—
Difficulties in chewing	Trigeminal nerve injury	—	—	—
Mouth remains open	Trigeminal nerve injury	—	—	—
Drops food	Facial nerve dysfunction	Yellow-star thistle poisoning	—	—
Immerses muzzle but does not drink	Eclampsia	Blister beetle poisoning (cantharidin)	—	—
Yawning, drowsiness	—	Yellow-star thistle poisoning, Senecio poisoning	Encephalomyelitis	—
Head tilt	Vestibular system lesion	—	Guttural pouch infection	—
Head pressing	Cirrhosis of liver, Serum hepatitis, Cerebral cortex damage	Poisoning (e.g., lead, senecio, locoweed, moldy corn)	—	—
Head shaking	Trigeminal neuralgia	—	Ear irritation (e.g., flying insects, spinose ear tick)	—
Jerky up and down movement of head	Neonatal maladjustment syndrome	—	—	—

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Behavioral Symptom	Dysfunction and Trauma	Nutrition, Allergy, and Toxins	Parasites and Infections	Handling and Management
<i>Neck:</i>				
Neck arching with retching (choking)	Obstruction of esophagus, Spasm of esophagus, Gastritis	—	—	—
Neck lowering, head extension	Esophagitis	—	African horse sickness, Strangles	—
Torsion of the neck	Vestibular system lesion	Dystrophic myodegeneration	—	—
Rigid neck	Intracranial meningitis	—	Strangles, Tuberculosis	—
Abnormal nodding during walk	Unilateral/unequal foreleg or hindleg lameness	—	—	—
<i>Legs:</i>				
Knocking/stomping	—	—	Chorioptic mange, Flying insects	—
Pawing	Distress	—	—	—
Swing leg lameness	Arthritis of shoulder joint, Coxitis, Gonitis, Sweeney	—	—	—
Excessive angle at hock joint	Gastrocnemius muscle or Achilles' tendon rupture	—	—	—
Kicks at abdomen	Abdominal pain	—	Flying insects	—
Uneven croup raising during walking	Unilateral/unequal hindleg lameness	—	—	—
<i>Body (miscellaneous):</i>				
Abnormal curve of back	Ankylosing lesions of vertebral column	—	—	—
Tail stiff and extended	—	—	Tetanus	—

Behavioral Symptom	Dysfunction and Trauma	Nutrition, Allergy, and Toxins	Parasites and Infections	Handling and Management
High tail carriage	—	Lactation tetany	—	—
Nonretracting penis	Pubic nerve damage	—	—	—
Shivering	—	Chlorinated hydrocarbon poisoning	—	—
Rolling	Abdominal discomfort	—	Rabies	—
Rearing	—	Allergic reaction	—	—
Shelter seeking	—	—	Flying insects	—
Uneasiness/restless	Discomfort (e.g., impaction)	Blister beetle poisoning, Allergic reaction	—	Transfusion reaction, Heat exhaustion
Groaning	Discomfort	—	—	—
Frequent lying down and getting up	Distress	Blister beetle poisoning	—	—
Nervousness	Adrenal medulla tumor	Poisoning (e.g., bracken fern, locoweed)	—	Subnormal early experience, Poor handling
Hyperexcitability	—	Poisoning (e.g., salt, pentachlorophenol, sodium fluoroacetate, organic phosphates)	Rabies	Drug reaction
Incessant walking	Serum hepatitis	—	—	—
Reluctance to lie down	Peritonitis, Purpura hemorrhagica	—	—	—
Abnormal resting stance	Leg/foot discomfort, Lameness	Fluorosis, Laminitis, Bracken fern poisoning	Encephalomyelitis	—
Extreme lethargy	Liver malfunction	—	Tularemia	—
Rigid stance	Myotonia, Peritonitis, Meningitis	—	—	—

Continued on next page

Behavioral Symptom	Dysfunction and Trauma	Nutrition, Allergy, and Toxins	Parasites and Infections	Handling and Management
Rigid stance with head extension, saw horse stance	Distress	—	Tetanus	—
Stands with both forelegs forward	—	Laminitis in forelegs	—	—
Stands with both hindlegs forward	—	Laminitis in hindlegs	—	—
Stands with one leg forward (pointing)	Navicular disease	—	—	—
Dog-sitting posture	Abdominal pain	—	—	—
Perception Changes				
Lack of ear movement	Deafness	—	—	—
No reaction to sounds	Acoustic nerve dysfunction, Trigeminal nerve lesion	—	—	—
Unusually sensitive to loud sounds	Facial nerve paralysis, Vision impairment	—	—	Procaine HCl overdose
Sudden noise causes tonic spasms	—	Strychnine poisoning	Tetanus	—
Impaired vision	Electric shock (lightning), Serum hepatitis, Pituitary tumor, Brain stem lesion, Cerebral cortex lesion, Optic nerve lesion, Superior colliculi lesion, Ruptured bladder	Poisoning (e.g., lead, selenium, salt, moldy corn, <i>Hypericum</i>), Snake bite, Stachybotryotoxycosis, Riboflavin deficiency, Aspergillosis	Encephalomyelitis, Periodic ophthalmia	—
Extreme sensitivity to light	—	Riboflavin deficiency	Periodic ophthalmia, Equine viral arteritis	—

Behavioral Symptom	Dysfunction and Trauma	Nutrition, Allergy, and Toxins	Parasites and Infections	Handling and Management
Extreme cutaneous sensitivity	Residual effect to lightning shock	Strychnine poisoning	—	—
Loss of corneal reflex	Ophthalmic nerve paralysis	—	—	—
Facial and oral anesthesia	Trigeminal nerve lesion	—	—	—
Unable to locate food by smell	Olfactory nerve lesion	—	—	—
Orientation Changes				
Aimless walking	Serum hepatitis, Neonatal maladjustment syndrome	Poisoning (e.g., locoweed, moldy corn, senecio, crotalaria)	Neonatal actinobacillosis	—
Circling	Cirrhosis of liver, Cerebral cortex lesion (occipital lobe), Brain stem lesion, Vestibular system lesion, Superior colliculi lesion	Poisoning (e.g., lead, moldy corn)	Encephalomyelitis, Coccidioidomycosis	Procaine HCl overdose
Loss of equilibrium/vertigo	Electric shock (lightning)	—	Foal septicemia	—
Coordination Changes				
Reluctance to feed off the ground	—	—	Tetanus	—

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Behavioral Symptom	Dysfunction and Trauma	Nutrition, Allergy, and Toxins	Parasites and Infections	Handling and Management
Lameness	Pain or anatomical abnormalities of limbs, feet, shoulder, or pelvis	Laminitis, Nutritional hyperparathyroidism, Ergotism, Fluorosis, Chronic selenium poisoning, Sweet clover poisoning	Lymphangitis, Vermineous thrombosis, Melioidosis, Coccidioidomycosis, Lyme disease	Improper foot care, Leg damage during handling or exercise
Lameness primarily after exercise	Splints, Metacarpal or metatarsal fracture	—	—	—
Lameness primarily after rest	Bone spavin	—	—	—
Irregular gait	Hypertrophic pulmonary osteoarthropathy	—	Encephalomyelitis	—
Short choppy gait	Osslets	—	—	—
High-stepping gait	Vision impairment	Lupine poisoning	—	—
Upward jerking of hindlegs with first steps	Stringhalt, Upward fixation of patella	—	—	—
Stabs feet into ground during trotting	Bone spavin	—	—	—
Shortened stride	Bucked shins	—	—	—
Hindleg suddenly pulled posteriorly just before contact in walking	Fibrotic and ossifying myopathy	—	—	—
Continuous foreleg running motions while recumbent	—	—	Encephalomyelitis	—
Toe dragging	Bone spavin	—	Cerebrospinal nematodosis	—
Drags hoof	Patellar luxation	Senecio poisoning	—	—

Behavioral Symptom	Dysfunction and Trauma	Nutrition, Allergy, and Toxins	Parasites and Infections	Handling and Management
Stumbling	Vision impairment, Pain in heels	Poisoning (e.g., bromide intoxication)	—	Heat exhaustion
Falling	Vestibular system lesion, Epilepsy	Milkweed poisoning	—	—
Staggering	Equine incoordination	Allergic reaction, Ryegrass staggers, Poisoning (e.g., death camas, locoweed, moldy corn)	Anthrax, Cerebrospinal nematodosis, African horse sickness Babesiosis	—
Hindquarter trembling induced by backing Stiffness	Shivering syndrome Purpura hemorrhagica, Azoturia/tying-up	— White muscle disease, Ryegrass staggers, Vitamin D deficiency, Poisoning (e.g., lead, selenium, sweet clover, fluoride), Lactation tetany	— Toxicoinfectious botulism, Equine influenza, Tetanus	— —
Resists locomotion	Myotonia, Azoturia, Stomach rupture, Purpura hemorrhagica, Pleuritis, Brain stem lesion	Laminitis	Encephalomyelitis, Tetanus Equine ehrlichiosis	Agonistic response to handling
Paralysis	Spinal cord injury, Medulla oblongata lesion	Poisoning (e.g., botulism, poison hemlock)	—	—

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Behavioral Symptom	Dysfunction and Trauma	Nutrition, Allergy, and Toxins	Parasites and Infections	Handling and Management
Posterior paralysis	Obturator nerve damage, Spinal cord lesion (lumbar)	—	Surra	—
Forelimb paralysis	Radial nerve damage, Spinal cord lesion (lower cervical)	—	—	—
Prostration/shock	Severe trauma, Cardiac failure, Internal obstruction	Anaphylaxis, Intoxication, Snake bite, Lead poisoning	Hypoderma larvae rupture	—
Dystonia	Basal ganglion disease	—	—	—
Opisthotonus	Meningeal disease	—	—	—
No tail movement	Cauda equina lesion	—	—	—
Tremors/muscle spasms	Stomach rupture, Serum hepatitis, Severe hypoglycemia, Epilepsy (grand mal)	Poisoning (e.g., moldy corn, milkweed, paspalum fungus)	Rabies, Toxicoinfectious botulism	—
Tonic spasms/convulsions	Eclampsia	Poisoning (e.g., lead, githagin, toxicoalgae, strychnine)	Tetanus, Mucormycosis	—
Clonic spasms	Neonatal maladjustment syndrome	—	—	—
Jerky movements	Cerebellar disease (dysmetria)	—	—	—
Incoordination	Basilar skull fracture, Eclampsia, Cirrhosis of liver, Severe hypoglycemia, Myelitis	Vitamin deficiency (A, thiamine), Poisoning (e.g., salt, bracken fern, senecio, paspalum fungus, castor	Toxoplasmosis, Encephalomyelitis, Ehrlichiosis, Foal septicemia	—

Behavioral Symptom	Dysfunction and Trauma	Nutrition, Allergy, and Toxins	Parasites and Infections	Handling and Management
Incoordination (cont.)		bean, moldy corn, milkweed)		
Lethargy/weakness	Hemolytic disease of newborn foals, Neonatal diarrhea of foals, Cerebral cortex damage	Nutritional deficiencies, Snake bite, Poisoning (e.g., lead, selenium, sodium fluoroacetate, inorganic arsenic)	Respiratory disease, Anthrax, Toxicoinfectious botulism, Tularemia, Neonatal septicemias and bacteremias (e.g., naval ill), Coccidioidomycosis, Large strongyle infection	Heat exhaustion
Weight shifted to forelegs in standing	—	Lathyrism	—	—
Maintenance Behavior Changes				
Loss of appetite	Hemolytic disease of newborn foals, Pharyngeal paralysis	Nutritional deficiencies (e.g., protein, minerals, vitamins), Urticaria, Poisoning (e.g., bracken fern, senecio, locoweed)	Lymphangitis, Respiratory disease, Anthrax, Malignant edema, Leptospirosis, Strangles, Blastomycosis	—
Ravenous appetite	Tumor of pars intermedia	—	—	—
Slow, deliberate ingestion	Pharyngitis, Lampas	—	—	—
Mastication poor	Dental abnormalities	Fluorosis	—	—
Irregular chewing	Dental problem	—	—	—
Head tilted while chewing	Dental problem	—	—	—
Quidding (drops bolus of food)	Dental problem	—	—	—

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Behavioral Symptom	Dysfunction and Trauma	Nutrition, Allergy, and Toxins	Parasites and Infections	Handling and Management
Refuses to eat hard grain	Dental problem	—	—	—
Difficulty in swallowing	Paralysis or physical interference in mouth or throat	White muscle disease, Poisoning (e.g., moldy corn, thallium, yellow-star thistle)	Encephalomyelitis, Listeriosis, Toxicoinfectious botulism	—
Stands with mouth open	Stomatitis	—	—	—
Excessive salivation	Foreign body in mouth, Pharyngeal paralysis, Swallowing difficulties	Allergic reaction, Poisoning (e.g., cyanide, pentachlorophenol, toxic algae, organophosphates)	Rabies, Vesicular stomatitis	Motion sickness
Refusal to drink	Pharyngitis	—	Strangles	—
Loss of suck reflex	Neonatal maladjustment syndrome	—	Neonatal septicemias and bacteremias	—
Excessive drinking	Diabetes insipidus, Pituitary tumor	—	Vesicular stomatitis	Boredom/restless energy
Thirst	Enteritis, Pituitary tumor (pars intermedia)	—	Babesiosis	—
Coughing	Heaves, Obstruction of esophagus, Hypertonic pulmonary osteoarthritis	Chronic bronchitis, Heaves, Cotton weed poisoning	Respiratory disease, Adenoviral infection, Foal pneumonia, African horse sickness, Bordetellosis, Bronchitis, Blastomycosis, Tularemia,	—

Behavioral Symptom	Dysfunction and Trauma	Nutrition, Allergy, and Toxins	Parasites and Infections	Handling and Management
Coughing (cont.)			<i>Corynebacterium equi</i> infection, Coccidioidomycosis	
Labored breathing, respiratory distress	Heaves, Pharyngitis, Nostril paralysis, Neonatal maladjustment syndrome	Allergic reaction (feedstuffs, bedding, pollen), Snake bite, Poisoning (e.g., lead, poison hemlock, cyanide, nitrite, dinitro compounds, organophosphates)	Equine influenza, Anthrax, Coccidioidomycosis, Mucormycosis	Heat exhaustion, Respiratory obstruction during treatment
Rapid breathing	Severe hypoglycemia, Hemolytic disease of newborn foals, Eclampsia	Allergic reaction, Cantharidin poisoning	Lymphangitis, <i>Corynebacterium equi</i> infection	Heat exhaustion, Drug reaction (stimulant)
Inspiration hurried, nostrils dilated Audible inhalation	Heaves	—	—	—
	Facial nerve damage, Laryngeal hemiplegia	—	—	—
Sweating	Gastritis, Rupture of large intestine, Eclampsia, Azoturia/tying-up	Laminitis, Cantharidin poisoning	—	—
Profuse sweating	Extreme discomfort, Severe hypoglycemia	Allergic reaction, Castor bean poisoning	African horse sickness	—
Sweating stops	Anhidrosis	Salt deficiency	—	Heat cramps, Heat exhaustion

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Behavioral Symptom	Dysfunction and Trauma	Nutrition, Allergy, and Toxins	Parasites and Infections	Handling and Management
Frequent urination or attempts	Cystitis, Urethral calculi	Allergic reaction, Poisoning (e.g., tannic acid, cantharidin)	Toxicoinfectious botulism	—
Slow painful discharge of urine	Vesical calculi	—	—	—
Colic	Constipation, Scrotal hernia, Ruptured bladder, Gastritis, Volvulus, Impaction of large intestine, Enterolith, Peritonitis, Visceral tumor, Tension of spermatic cord	Allergic reaction, Poisoning (e.g., castor bean, chlorinated hydrocarbon, fluoroacetate, corn-cockle)	Coccidioidomycosis, Strongyles, Anthrax	—
Weakness	—	Locoweed poisoning	Equine infectious anemia, Botulism	—
Rubbing	—	Allergic dermatitis from insect bites	Lice, mites	—
Social Abnormalities				
Solitary tendencies	Pending parturition	Locoweed poisoning	—	Abnormal early social development
Loss of foal-mother bond	Neonatal maladjustment syndrome	—	—	—
Seeks only human social contact	—	—	—	Social imprinting on humans

Behavioral Symptom	Dysfunction and Trauma	Nutrition, Allergy, and Toxins	Parasites and Infections	Handling and Management
Docility	Pituitary tumor (pars intermedia)	—	—	—
Change in personality or temperament (e.g., hyperexcitability, lethargy)	Liver malfunction	—	—	—
Irritability	Hypoglycemia, Cryptorchidism	Vitamin D deficiency	Listeriosis, Rabies, Lice	Drug overdose
Aggressiveness	—	—	Rabies	Boredom, Poor handling, Sexual frustration
Viciousness	Pathologic nymphomania	—	Rabies	—
Increased libido	Cryptorchidism	—	—	Sexual isolation
Prolonged estrus	Irritation of clitoris by foreign body, Cystic ovary, Neuroendocrine disorder	—	—	—
Prolonged anestrus	Infantilism, Ovarian malfunction, Pseudocyesis	Undernourishment, Obesity	—	Poor nutrition
Impotence	—	Undernourishment	—	Aversive experience during breeding, Frequent ejaculations

Problem Behaviors (Vices)

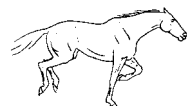
Refusal to work	Liver dysfunction	—	—	Heat exhaustion
Difficulty to bridle	Dental abnormality	—	Spinose ear tick	—

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Behavioral Symptom	Dysfunction and Trauma	Nutrition, Allergy, and Toxins	Parasites and Infections	Handling and Management
Stall walking	—	—	—	Nervousness/excess energy
Weaving	—	—	—	Procaine HCl overdose
Cribbing	Dental abnormality	—	—	Nervousness/excess energy
Pica (e.g., dirt, wood)	—	Nutritional deficiencies	Parasitic infection	Boredom, Poor social development
Coprophagia	—	Need for roughage	—	Boredom —
Fence chewing	Dental abnormality	Need for roughage	—	Boredom/restless energy
Digging	—	—	—	Nervousness/excess energy
Masturbation	—	—	—	Excess sexual energy
Charging/savaging	Hormone imbalance (e.g., ovarian tumor)	—	—	Poor handling, Anxiety
Striking	—	—	—	Agonistic response to handling
Kicking	—	—	—	Agonistic response to handling
Rearing	—	—	—	Agonistic response to handling
Bucking	—	—	—	Agonistic response to handling
Bolting	—	—	—	Agonistic response to handling
Jibbing	Vision impairment	—	—	Agonistic response to handling
Shying	Vision impairment	—	—	Fear response, Agonistic response to handling

(Blood and Henderson 1963; Catcott and Smithcors 1972; Siegmund 1973; Marinier 1980; Colahan et al. 1991; Aiello 1998; Mair et al. 1998)

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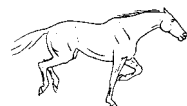
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Index



- Aanes, W.A., 173
- Abnormal
- agonistic behavior, 267–269, 362–363
 - behavior, 198, 362–368, 370–384
 - maternal behavior, 208
 - sexual behavior, 175–181, 196–198
 - social behavior, 78, 226, 363, 366, 382–383
- Accommodation, 22–23
- Actinobacillosis, 375
- Activity patterns, 237, 305, 308–310
- Adams, O.R., 117
- Adipsia, 365, 380
- Adoption, 206, 223–224
- African horse sickness, 370, 372, 377, 380–381
- Age ratio, 213–214, 234
- Aggression, 61, 73, 80, 163, 172, 175–176, 179, 181, 205, 208, 246–247, 251, 253, 257–261, 267–269, 277, 279, 281–282, 301, 310, 324, 345, 363, 366, 368, 383
- stallion conflicts, 216–217, 228, 241, 249–250, 259–264, 318–319
- (see also Agonistic behavior)
- Aggressive distance (see Defensive distance)
- Agonistic behavior, 70, 253–269, 271, 283, 353, 362, 364, 377, 384
- Aiello, S.E., 364–365, 384
- Ailments, 363–366, 370–384
- Alarm, 217, 253–257, 272–273, 276, 278, 281–282, 284, 293, 299–300
- Albiston, G., 73
- Alert distance, 61
- Alertness, 92–94, 184, 253–255, 262, 275
- backward attention, 273, 276–277
 - forward attention, 273–275, 298
 - lateral attention, 273–276
- Alexander, A.J., 31, 76, 102, 112, 125, 301
- Allelomimetic behavior, 255
- Allen, D.B., 19, 23
- Allen, W.R., 4, 195
- Allergy (Allergic reaction), 269, 362, 365, 370–384
- Allogrooming, 77, 149, 157–159, 190, 206, 228, 300
- (see also Mutual grooming)
- Altmann, M., 219
- Amann, R.P., 164, 170
- Amble (see Pace)
- Amoss, M.S., Jr., 269
- Anaphylaxis, 378
- Anatomy, 7, 12, 20, 30, 33, 41
- Anchitherium*, 6, 9

- Andersen, S.R., 19
 Anderson, M.K., 346
 Anemia, 382
 Anesthesia, 36, 39, 360–361, 364, 375
 Anestrus, 183–184, 193–196, 383
 Anhidrosis, 381
 Anorexia, 365, 379
 Anthony, D.W., 16–17
 Anthrax, 377, 379, 381–382
 Antipredator strategies, 310
 Appetite, 33, 128, 130–136, 379
 Applied ethology, 327–384
 Approach, 34, 48, 60–61, 70, 79–84, 87–89, 93, 95, 100, 141, 146, 159, 165, 178, 183, 190, 196, 204, 206–207, 217, 220, 222, 224, 227, 229, 238–239, 250–252, 254–256, 259, 261–265, 267, 271–272, 275, 277–279, 284, 301, 333, 337, 341, 344, 350
 distance, 61, 93, 350
 (see also Following response)
 Araba, B.D., 248–249
 Archer, M., 130–131
 Arnold, G.W., 123, 228, 313
 Aronson, L., 269
 Aronson, R., 25, 31, 221, 298, 301
 Arteritis, 374
 Arthritis, 372
 Arthur, G.H., 193
 Asa, C.S., 168, 172–173, 183–184, 188, 190, 195–196, 198, 252, 323
 Asai, Y., 128
 Ass, 3–4, 14, 17
Astrohippus, 6, 10–11, 13
 Ataxia, 364, 377
 Avoidance, 27, 32, 61, 78, 82, 88, 93, 95, 130, 150, 183, 190, 205–206, 226, 229, 233, 238–240, 245, 253, 255–256, 264–265, 267, 275, 279, 305–306, 310, 312, 333, 341, 344, 368
 distance, 61, 255
 learning, 98, 100, 103, 107–109, 348–349
 -retreat, 48, 60, 259
 Azoturia, 364, 377, 381
 Azzie, M.A.J., 194, 196
 Babesiosis, 377, 380
 Back, W., 41, 336
 Backing, 42, 48, 68, 98, 337–338, 343, 357, 359, 377
 Bacteremias, 365, 379–380
 Baer, K.L., 111, 243
 Baile, C.A., 126
 Baker, A., 111
 Baker, J.P., 103, 125, 136
 Baker, R.J., 4
 Balking, 48, 256, 267–268, 277, 281–282, 351
 Ballotade, 48, 50, 52
 Bands, 211–219
 bachelor, 213, 215–216, 243
 fission of, 213, 216
 formation of, 213, 216, 230
 harem (family), 212–216, 248, 252, 322
 juvenile (peer), 213
 stability of, 235, 319–320, 325
 Banks, E.M., 259
 Bannikov, A.G., 16, 138
 Barber, J.A., 72, 207
 Barbey, P., 120
 Barn (see Stable)
 Barr, B.S., 364
 Barrow, P., 353, 356–357, 360
 Baskin, L.M., 213, 219, 231, 238, 240, 257
 Bats, 22, 312
 Baucus, K.L., 191, 321, 337
 Beatey, S.A., 206, 243
 Beauchamp, G.K., 29
 Beaver, B.V., 111, 268–269, 366, 368
 Bedding, 332, 381

- Behavioral
 considerations in horse
 management, 329–339
 indicators of health and well-being,
 362–368
 (see also Symptoms)
 manipulation, 96, 108, 340–361
Bell, R.W., 107–108, 333, 346
Belonje, P.C., 196
Benirschke, K., 3
Berger, A., 117
Berger, J., 72, 82–83, 90, 128, 150,
 157, 182, 200–201, 207, 211–212,
 215–217, 231, 234–236, 238–239,
 248–249, 251, 255–257, 306–307,
 309–311, 313, 315–325
Berndtson, W.E., 164, 169–171
Bielanski, W., 169, 368
Biles, D.R., 39
Bioenergetic considerations, 307–308
Birth, 65–68, 82–84, 139, 192,
 200–207, 215, 221, 224, 252,
 315–318, 350, 366
 (see also Parturition)
Bite threat, 48, 57, 205, 245, 258,
 263, 277, 300
Biting, 48, 57, 80, 84–85, 87–89, 125,
 143, 151, 167, 175, 207, 245,
 259–260, 263, 268–269, 277,
 279, 301, 356, 368
Blackshaw, J.K., 194
Blakeslee, J.K., 133, 159, 200, 206,
 223, 226, 249–250, 252, 265
Blastomycosis, 379–380
Blinking, 36, 48, 59, 297, 360
Blood, D.C., 384
Blow, 48, 254–255, 282–284,
 293–294, 299–300, 310
Bolting, 48, 256, 267–268, 277, 343,
 366, 384
Bonds, 77–79, 82, 208, 219–222,
 224–226, 228–230, 232, 366
 foal–mare, 224–227, 382
 heterosexual, 229–231
 interspecies, 231–232
 mare–foal, 82, 208, 220–226
 paternal, 228, 231
 peer, 227–229
 (see also Social attachment)
Bone
 fracture, 264, 376, 378
 nomenclature, 12
 spavin, 376
Bordetellosis, 380
Boredom, 122, 334–335, 350, 352,
 367, 380, 383–384
Borell, E. von, 331
Botulism, 377–380, 382
Bouissou, M.-F., 107, 245
Bouman, I., 4
Bouman, J., 4
Bowling, 48, 58
Bowling, A.T., 3, 322
Boxing, 48, 50, 259
Boy, V., 74
Boyd, L.E., 4, 68, 129, 146, 200,
 206–207, 223, 225–226, 231,
 249, 261, 324, 330, 334, 366
Brain, 7–8, 11–12, 39, 164
 disorders, 268, 364, 374–375, 377
Brain, P.F., 73
Breathing, 66, 121, 202, 273, 278,
 299–300, 360
 abnormalities, 381
Breazile, J.E., 39
Brentjes, B., 16–17
Brewer, B.D., 366
Bristol, F., 166
Bronchitis, 380
Brown, D.R., 16–17
Brown, S., 24–25
Brownlie, S., 65
Brownlow, M.A., 353, 359
Browsing, 5, 8–9, 125, 128, 132
 (see also Feeding)
Bucked shins, 376
Bucking, 37–38, 48, 50, 53, 84, 87,
 227, 256, 279, 281–282, 366, 384

- Buck-jump, 48, 50, 53, 256
 Budzynski, M., 129, 142, 146–147
 Burkhardt, J., 193
 Burnham, J., 80
 Burro, 4
 Burton, F.L., 29
 Bushong, D.M., 346
 Butler, W.R., 340
 Butterfield, R.M., 183, 199–200
 Buttock, 12, 40, 165
 Byers, S.W., 164
 Byrne, R.J., 364
- Caanitz, H., 137
 Caballine horses, 14
 Calculi, 365, 382
 Calhoun, M.L., 27–28
Calippus, 6, 10–11
 Callicott, R.B., 65
 Cameron, E.Z., 72, 82, 310, 319, 321
 Campitelli, S., 67, 200–201, 204
 Cannon bone, 8, 12–13, 357
 Canter, 43, 45, 47–49, 110, 331
 Capriole, 48, 50, 53
 Carbonaro, D.A., 122
 Cardiac failure, 378
 Care-giving behavior, 70, 157, 202–207, 218, 231
 Care-seeking, 70, 141, 205
 Carenzi, C., 67, 200–201, 204
 Carini, C.M., 77, 158
 Carlson, G.P., 338
 Carnevale, J., 129, 138
 Carpus, 12, 56
 Carson, R.G., 128
 Casting, 352, 359–360
 Castration, 172–173, 178, 216, 237, 269
 Catcott, E.J., 36, 353, 384
 Catlin, G., 352
 Caudle, A.B., 189, 227
 Cecal digestion, 9, 124
 Cerling, T.E., 9
 Chaffin, M.K., 368
- Champing, 57, 371
 (see also Snapping)
 Chandley, A.C., 4
 Chasing, 16, 48, 83, 87–89, 141, 216–217, 227, 229, 252, 263–264, 317
 Chen, S.C., 338
 Chewing, 37, 48, 57, 86, 99, 125–126, 133, 136, 159, 253, 279, 363, 365–368, 371, 379, 384
 Choking, 352, 372
 Christopher, M., 25
 Chromosomal polymorphism, 3
 Chromosome number, 3–4
 Church, D.C., 31, 132
 Circling, 48–49, 54, 87, 90, 93, 141, 159, 201, 238, 259–260, 364, 375
 Cirrhosis, 354, 371, 375, 378
 Clark, D.K., 337–338
 Clarke, J.V., 111
 Classification of equids, 4, 6, 10
 Clay, C.M., 164
 Clayton, H.M., 41
 Clever Hans (Kluge Hans), 25, 271
 Cloix, J., 126
 Clutton-Brock, J., 17
 Clutton-Brock, T.H., 246–247
 Coates, K.P., 313
 Coccidioidomycosis, 375–376, 381–382
 Cogen, D.C., 102, 107
 Cognition, 99, 110–111
 Colahan, P.T., 362, 384
 Coleman, D.A., 104
 Colic, 33, 334, 365, 382
 Collery, L., 200, 217
 Collins, M.N., 338
 Combat, 71, 253, 259–260, 262–264, 299
 Combie, J., 361
 Comfort behavior, 149–160, 365
 Communicative behavior
 (Communication), 270–302
 acoustical, 174, 189, 283–300, 348

- chemical, 112, 139, 301–302
 tactile, 67, 163, 174, 185, 189, 272,
 274–275, 278, 300–301, 336,
 342, 348
 visual, 87, 91, 126, 163, 173–174,
 190, 205, 221, 225, 262–263,
 270–282, 301, 336, 340, 348
 Competition, 7, 65, 192, 232, 241,
 245, 248, 257, 313, 324
 Conditioning, 96–109, 163, 337, 341,
 348–349, 351, 368
 classical, 96–98
 free-operant, 100–101, 108
 instrumental (operant), 96, 98–109
 Cooperation, 139, 141, 157–159, 190,
 206, 215, 218, 319
 Constipation, 382
 Contraception, 323–324
 Convulsions, 78, 378
 (see also Neonatal maladjustment
 syndrome)
 Cooper, J.J., 332, 368
 Coprophagia (Coprophagy), 76, 112,
 133, 136, 330, 384
 Copulation, 48, 81, 165–179,
 181–182, 188, 190–191, 195,
 200, 217, 252, 260–261, 267,
 281–282, 315, 323, 325, 368
Cormohipparion, 6, 10–11
 Corpus nigrum, 19–20
 Cough (Coughing), 37, 48, 283, 300,
 365, 380
 Cougouille-Gauffreteau, B., 198,
 269
 Counterconditioning, 337, 341, 351
 Courbette, 48–49, 52
 Court, M.H., 367
 Cowtan, P., 150, 310
 Cox, J.E., 68, 205
 Coxitis, 372
 Crawford, B.H., 111
 Cregier, S.E., 337
 Cribbing, 48, 57, 111, 366–368,
 384
 Croup, 12, 37, 40, 69, 157–158,
 165–167, 372
 Croupade, 48–49, 52
 Crowe, C.W., 172
 Crowell-Davis, S.L., 71, 76–77, 79,
 84, 86–87, 129, 138, 150–153,
 189, 206–207, 227, 243,
 248–249, 365
 Cryptorchidism, 173, 383
 Csapó, G., 340
 Cuddeford, D., 337–338
 Cummins, K.A., 108
 Cunningham, C., 325
 Curtis, S.E., 88, 142, 259
 Cymbaluk, N.F., 126, 334
 Cystitis, 365, 382

 Dagg, A.I., 40
 Dallaire, A., 120–122
 Dancing, 48–49, 83
 Danhof, K., 61
 Daniluk, P., 131
 Dark, G.S., 58–59, 100, 265, 270,
 273–280, 282
 (see also Van Asten)
 Dawson, J., 150, 310
 Deafness, 374
 De Mazières, J., 158
 De Moor, A., 19, 24
 de Rouck, A., 22
 Defecation, 38, 48, 69–70, 76, 130,
 144–148, 250, 254, 263,
 281–282, 331, 339
 Defensive distance, 61
 Deficiency, 136, 365–366, 374,
 377–378, 381, 383
 Del Piero, F., 364
 Dellmeier, G.R., 337–338
 Denniston, R.H., 211, 216, 238–239,
 251, 319
 Dental problems, 365–366, 379–380,
 383–384
 Desensitizing, 268, 337, 351
 Desrochers, A.M., 364

- Development, 164, 182–183, 186,
192, 229–230, 305, 316–318,
320, 366, 384
perinatal, 65–71, 112, 225–226,
310, 342, 382
post-natal, 71–84, 91, 172,
215–216, 226, 325, 346
- Diabetes, 380
- Dial, D., 24
- Diarrhea, 379
- Diehl, N.K., 172
- Diesem, C.D., 21, 23
- Diet, 9, 76, 103, 121, 124, 126,
131–136, 147, 193, 200, 309,
313, 315, 320, 334, 367–368
- Dinohippus*, 6, 10–11, 13
- Digging, 50, 126, 272, 367, 384
- Discomfort, 33, 70, 139, 177, 179,
200–201, 204–205, 222, 224,
272, 277, 299, 306, 313, 335,
354–355, 363, 365, 370, 373, 381
- Disorientation, 225, 364
- Dispersal, 13, 17, 90, 215–216, 228,
230–231, 237, 305, 313, 315–318
(see also Emigration)
- Displacement behavior, 39, 50, 201,
272, 299
- Disease, 39, 269, 325, 362, 364–366,
370–384
- Distress, 70, 141, 225, 229, 372–374,
381
- Dixon, J.C., 25, 105–106, 113, 298
- Dixon, P.M., 365
- Dixon, R., 367
- Dobroruka, L.J., 84
- Docility, 184, 383
- Dock, 12, 158
- Dodman, N.H., 269, 367–368
- Dog-sitting, 363, 374
- Dolan, J.M., 4
- Domestication, 14–17, 96
- Dominance, 57, 77, 83, 88, 103, 107,
109, 138, 141, 146, 153, 159, 173,
198, 200, 206, 211, 216–218, 223,
228, 238–240, 242–252, 254–255,
259, 261–265, 267–269, 316,
318–320, 322, 332, 334, 345, 352
establishing and maintaining rank,
245–247
factors influencing rank, 247–250
influence of rank on daily activity,
250–252
- Donkey, 4, 105–106
- Doreau, M., 126
- Dougherty, C.T., 125
- Dougherty, D.M., 108
- Dougherty, J., 361
- Douglas, J., 61
- Douglas, R.H., 195
- Downey, B.R., 194
- Dowsett, K.F., 164, 175
- Dreaming, 121
- Drinking, 16, 39, 48, 74, 124–125,
136–138, 144, 241, 244,
246–247, 264, 305, 318, 330,
332, 371, 380
- Driving, 48, 60, 141, 165, 207,
217–218, 230–231, 242, 248,
251, 255, 258–259, 261, 279, 333
(see also Herding)
- Drowsiness, 48, 71, 118–123,
273–274, 361, 364, 371
- Drug reaction, 361, 370, 373, 381, 383
- Drummond, A.J., 68
- Duke-Elder, S., 19
- Duncan, P., 4, 17, 72–74, 81–82, 118,
124, 126, 128–129, 132, 150,
159, 261, 306, 309–310,
313–316, 320–321, 323–325
- Duren, S.E., 125
- Dusza, K., 167
- Dysmetria, 378
- Dystonia, 378
- Dziedzic, R., 129, 142, 146–147
- Dzigettai, 4
- Eagle, T.C., 323
- Eagleton, R.D., 23

- Ear, 12, 18, 26–27, 32–34, 36–37, 40,
 56, 83, 153, 190, 224, 273, 281,
 344, 354
 abnormalities, 143, 362, 365,
 370–371
 laid back, 26, 48, 57, 60, 66, 88,
 141, 173, 183, 186, 257, 259,
 264, 271, 277
 lateral, 26, 48, 58, 60, 66, 118, 265,
 274–275, 281
 movements, 26, 36, 59–61, 67,
 91–92, 95, 120–121, 125, 224,
 253, 270, 274, 276, 297–298,
 360, 364, 370, 374
 parasites, 365, 371, 383
 pricked, 26, 48, 60, 253–254, 262,
 272, 274, 278, 298
 Earl-Costello, S.A., 206, 243
 Early experience, 71, 78–79, 92,
 108–109, 181, 221, 226, 238,
 341–346, 350, 366, 373, 382
 Ebhardt, H., 14, 132, 218, 249
 Echteleer, S.M., 26
 Eckley, S., 332
 Eclampsia, 364, 371, 378, 381
 Ecological influences, 303–325
 by horses on their environment,
 313–314
 on activity patterns and movements,
 308–310
 on development, 316–318
 on dispersal, 215, 317–318
 on home range, 305–307
 on population dynamics, 323–325
 on reproduction, 183, 193, 228,
 252, 315–323, 333
 on social structure and stability,
 318–320
 on territoriality, 308
 on use of sanctuaries, 310–311
 Edema, 370, 379
 Edwards, G.B., 68
 Edwards, P.J., 132
 Eggleston, A., 128
 Eglitis, I., 21, 23
 Egrets, 160, 311–312
 Ehrlichiosis, 377–378
 Eichhorn, K., 117, 136
 Ejaculation, 37–38, 48, 153, 163–165,
 167–172, 174–181, 190, 281,
 368, 383
 Ekins, J.R., 132
 Eldridge, F., 224
 Eldridge, P.R., 365
 Electric shock, 39, 109, 332, 374–375
 Eliminative behavior, 130, 144–148,
 250, 330, 365
 (see also Defecation and Urination)
 Ellard, M.-E., 248
 Ellegren, H., 14
 Elliot, O., 341
 Emigration, 215–216, 325
 (see also Dispersal)
 Encephalomyelitis, 364, 370–371,
 373–378, 380
 Enclosures, 198, 329–332
 Energy, 26, 41, 131, 207, 241,
 283–284, 299, 307–309, 319,
 334, 350, 367, 380, 384
 Enterolith, 382
 Eohippus (see *Hyracotherium*)
 Epel, N.C., 3
Epihippus, 6, 8, 10
 Epilepsy, 364, 377–378
 Epstein, H., 3, 16–17
 Equid species, 3–11, 13–16, 38, 40,
 61, 83, 128, 150, 190, 318
 Equilibrium, 32–33, 375
 Equini, 6, 10–11, 13
Equus, vii, 3–7, 10–11, 13–14, 16, 29
 E. africanus, 3–4, 14, 17
 E. alaskae, 13
 E. asinus, 4, 17, 105–106
 E. caballus, vii, 3–4, 14
 E. ferus, 4, 16
 (includes *Equus ferus*
 przewalskii)
 E. francisi, 13

- E. grevyi*, 3–4
E. hartmannae, 3–4, 14
E. hemionus, 3–4, 14
E. khur, 3–4, 14
E. kiang, 3–4, 14
E. laurentius, 13
E. quagga, 3–4, 14
E. scotti, 13
E. simplicidens, 13
E. zebra, 3–4, 14
 Esophagus, 12, 125, 365
 disorder, 144, 365, 371–372, 380
 Estep, D.Q., 189, 206, 243
 Estes, R.D., 29, 31
 Estrous cycle, 183–184, 188,
 191–196, 321, 368, 383
 manipulation of, 192–195
 Estrus, 31, 38, 81, 145, 166, 169–170,
 173–174, 178, 184–198, 217,
 229, 252, 302, 315
 prolonged, 192, 196, 383
 silent, 192
 split, 185, 191, 196
 Etherington, M.G., 14
 Ethogram, 48
 Ethology, vii, viii, 327
 applied, 327–384
 Evans, J.W., 183–184, 186, 193, 335,
 346
 Evolution, 3–17, 38
 Ewing, S.A., 331
 Exercise, 84, 90, 125–126, 137, 167,
 269, 333–334, 350, 367–368, 376
 Exploratory behavior (see
 Investigative behavior)
 Extinction of a response, 100–102,
 350
 Eye rolling, 48, 59, 364, 370
 Eye, 8, 11–12, 18–24, 27, 34, 36–37,
 49, 58, 66–67, 71, 107, 119–120,
 125, 149, 190, 224, 254,
 273–274, 276–278, 281,
 297–298, 359, 362
 lid, 36, 58–59, 118, 254, 265, 273,
 362, 370
 movements, 18, 36, 48, 58–59, 61,
 91–92, 95, 120–121, 274–276,
 364, 370
 shine, 22
 Facial expressions, 33, 58, 83, 88,
 119, 190, 270, 272–281,
 362–363, 370
 Fagen, R.M., 84
 Falling, 339, 343, 359, 377
 Farley, C.T., 307
 Faulkner, L.C., 168–171
 Fay, R.R., 26
 Fear, 71, 78–80, 95–97, 113,
 175–176, 190, 225–226, 256,
 265, 268, 281–282, 333, 337,
 344, 346–347, 350–351, 353,
 364, 366, 384
 Feaster, J.P., 131
 Fecal pile (see Stud pile and Defecation)
 Feces (see Defecation and Coprophagia)
 Fecundity, 324
 Feeding, 329, 333–335, 337,
 367–368, 375
 (see also Ingestive behavior ,
 Browsing, Diet, and Grazing)
 Feet, 5, 7–8, 11, 18, 37, 39–40, 42,
 49, 54, 56, 65, 67, 69, 77, 93,
 153, 204, 253, 256, 258, 271,
 331, 335–336, 341, 344, 359,
 364–365, 373, 376
 Feh, C., 158, 319–320, 322, 325
 Feist, J.D., 15, 39, 48, 72, 81, 83, 95,
 121, 133, 138, 142, 146, 148,
 157–158, 168, 173, 199–200,
 211–219, 228, 230–231, 233–239,
 243, 248–252, 254–256, 259,
 263–265, 267, 324
 Feldman, J., 208
 Fences, 102, 136, 152, 179, 329–330,
 367, 384
 Fertility, 170, 172, 176, 320–323

- Fetal
 membranes, 65–66, 70, 201–205,
 221, 272
 movement, 65
 Fetlock, 11–12, 39, 56, 270
 Fibula, 11–12
 (see also Splint bone)
 Fiske, J.C., 104, 349
 Flade, J.E., 201
 Flank, 12, 38, 68, 91, 95, 139–141,
 152, 165, 189, 205, 263, 269,
 300–301, 359
 Flannery, B., 106
 Flehmen, 29–31, 48, 58, 71, 88, 94,
 146, 165, 168, 190, 201, 205,
 273, 301
 Flight, 24, 34, 61, 92, 253, 255–256,
 267–268, 272, 310, 341, 348,
 350, 353
 distance, 61, 255, 351, 348, 350
 Flooding, 351–352
 Florian Buchner, H.H., 335
 Fluorosis, 373, 376, 379
 Foal heat, 177, 183, 195, 315
 Following response, 48, 70–71, 77,
 79, 89, 168, 205, 218, 223–225,
 229, 251, 297, 344
 Food
 preference, 111, 124, 130–135
 selection, 32, 76, 107, 111, 125,
 130–136, 313, 331
 (see also Feeding)
 Foraging (see Feeding and Food)
 Ford, B., 71, 135
 Foreign body
 against clitoris, 383
 in mouth, 380
 (see also Obstructions)
 Foreleg lift, 48, 50, 272, 341
 Forest horse, 15–16
 Fostering, 79, 112, 141, 205–206,
 208, 220–221, 224, 226, 366
 Fowler, M.E., 353
 Fox, M.W., 341, 345
 Francis-Smith, K., 76, 128, 130, 142,
 147
 François, J., 22
 Franke Stevens, E., 216, 318–319, 323
 Fraser, A.C., 353
 Fraser, A.F., 65, 185
 Fraser, J.A., 33, 363
 Freeman, D.A., 126, 334
 French, N.P., 367
 Fretz, P.B., 196, 198
 Friend, T.H., 103, 111, 243, 333,
 337–339, 346
 Fujii, Y., 331
 Gabel, A.A., 361
 Gait, 41–49, 68, 165, 256, 282, 307,
 348, 350, 364, 376
 Gallop, 40–43, 45, 47–50, 70–71, 80,
 84, 86–87, 89–90, 110, 150, 227,
 256, 282, 307
 Ganskopp, D., 138, 305–306
 Garcia, M.C., 172, 175, 178, 188
 Gardner, L.P., 99, 103
 Gardner, R.E., 172
 Garrott, R.A., 213, 323
 Gaskin, 12, 68, 91, 157
 Gastritis, 365, 372, 381–382
 Gates, S., 240
 George, M., Jr., 13–14
 George, T.K., 84
 Geschwind, I.I., 184, 186
 Gestation, 65–66, 183, 199–200, 321
 Getting up, 48, 55–56, 66–70, 139,
 153–156, 201, 203–206, 220,
 352, 360, 363, 373
 Gevers, E., 250
 Ghor-khar, 4
 Gibbs, A.E., 338–339
 Giebel, H.-D., 105, 113
 Gillham, S.B., 368
 Ginther, O.J., 168, 173, 182–186,
 188, 190–196, 198, 252
 Girth, 12, 68, 91, 200
 Glatthaar, A., 48

- Gleize, J.C., 325
 Glendinning, S.A., 111, 246
 Glover, T.D., 164
 Göbel, F., 132
 Goldfoot, D.A., 168, 173, 183–184, 188, 190, 196, 198, 252
 Goldman, L., 25
 Goldschmidt-Rothschild, B. von, 48, 88, 158, 213, 215–216, 228, 245, 247, 249, 267
 Gonitis, 372
 Gonyou, H.W., 368
 Gordon, I., 194
 Górecka, A., 109
 Götherström, A., 14
 Grasp, 48, 57, 99
 Grassia, A., 228
 Grazing, 9, 11, 61–62, 72–74, 93, 100, 107, 111–112, 126–132, 146–147, 168, 188, 190, 222, 227, 229, 237–238, 241, 243–247, 261–262, 276–277, 309, 311, 313–314, 321, 330–331, 356
 (see also Feeding)
 Green, H.D., 200, 213, 233–236, 238
 Green, N.F., 200, 213, 233–236, 238
 Greenberg, S.A., 246–247
 Greenwood, P.J., 246–247, 251
 Groan, 33, 48, 70, 205, 224, 278, 283–284, 292, 298–299, 363, 373
 Grogan, J.W., 42
 Gröngroft, B., 243, 245
 Grooming, 57, 70, 77, 80–81, 150–153, 158, 278, 283, 300, 329–330, 335, 359, 365
 (see also Mutual grooming)
 Grossman, J.D., 23, 28–29, 31, 60, 165
 Group distance, 62, 138, 238–239, 262, 318
 Groves, C.P., 3–4, 16
 Grubb, P., 4
 Grunt, 48, 298–299
 Grzimek, B., 24–25, 35, 38, 40, 78, 95, 112–113, 226, 231, 237, 245, 247, 256, 366
 Guillemot, P., 120
 Haag, E.L., 103, 250
 Habitat selection, 7, 15, 233, 237–238, 240–241, 305–309
 Habitat utilization, 126, 130, 132–138, 233, 236–237, 240, 305–311
 Habits, 13, 109, 272, 350, 352, 366
 Habituation, 96–97, 256, 268, 340, 347, 351
 Hack, M.A., 264, 284, 301
 Haenlein, G.F.W., 131, 136
 Hafez, E.S.E., 20, 168–169, 179, 283
 Hafs, H.D., 186, 188, 195
 Hamilton, G.V., 101
 Hamilton, M.J., 4
 Handling, 27, 60–61, 71, 78–79, 92, 96, 98, 108–110, 113, 160, 174, 176–179, 205–206, 226, 231, 238, 259, 268–270, 275, 279, 282, 284, 299, 301, 329, 333, 335–361
 improper, 179–181, 265, 277, 362, 366, 370, 373–377, 379–384
 Hanggi, E.B., 106–107
 Hansen, K.V., 321
 Hansen, R.M., 133, 135
 Harlow, H.F., 106
 Harman, A.M., 19, 22–23
 Harrison, L.A., 183, 195
 Hart, B.L., 172, 269
 Harver, E., 23
 Harvey, P.H., 72–73, 81–82, 321
 Hassenberg, L., 152
 Hastie, H., 65
 Hatakeyama, H., 128, 331
 Hausberger, M., 96, 346
 Haviland, J.C.S., 48, 253, 273
 Hawkes, J., 131
 Hay (see Roughage)

- Hay dunking (Hay moistening), 48, 57, 98–101, 111, 126
 Head, 11–12, 27, 34, 36, 38, 50, 54, 56–60, 66–68, 77, 87–89, 95, 118–119, 125, 139–140, 152, 165, 168, 202, 205, 207, 224, 229, 239, 254, 256–260, 265, 270–281, 301, 311, 331, 333, 336, 341, 353, 362, 370–371, 379
 bump, 48, 54, 174, 245, 257, 263
 extension, 19, 29, 37, 48–49, 57–60, 68, 92, 94–95, 119, 139, 165, 255, 257–259, 275, 277–279, 283, 363–364, 372, 374
 flexion, 19, 37, 48, 50, 58, 92, 110, 165, 262, 265, 272, 274, 283
 movements, 19, 32, 58, 66–68, 70, 98, 124–125, 224, 253, 262, 283, 365, 371
 nodding, 25, 47, 272, 297, 365
 pressing, 363, 371
 restraint, 352, 354, 356, 359
 shaking, 36–37, 48, 56, 153, 186, 281, 365, 371
 stretch, 48, 59, 152
 threat, 48, 60, 88, 239, 247, 257–258, 261, 279
 tossing, 48, 58, 141, 265, 277
 turn, 19, 36, 48, 57, 59, 61, 91–92, 140–141, 151, 184, 190, 202, 256, 278, 280, 297–298, 300, 337, 341, 359
 Hearing, 26–27, 98, 364, 370
 Heart rate, 66, 109, 120, 158, 276, 337–338, 354, 360
 Heat cramps, 381
 Heat exhaustion, 364–365, 373, 377, 379, 381, 383
 Heaves, 365, 380–381
 Hebel, R., 21–22
 Hechler, B., 158, 248
 Hedges, M., 131
 Heffner, H.E., 26–27
 Heffner, R.S., 26–27
 Heglund, N.C., 41, 307
 Heird, J.C., 102, 107–108, 333, 346
 Hemiones, 3–4, 14, 17
 Hemolytic disease, 379, 381
 Henderson, J.A., 384
 Hendrikse, J., 199
 Hendrix, G., 78, 100, 110
 Henry, M., 166
 Hepatitis, 371, 373–375, 378
 Heptner, V.G., 16
 Herd structure, 211–115
 Herding, 48, 60, 79, 198, 204, 217–218, 231, 344
 (see also Driving)
 Hernia, 365, 382
 Herrera, E.A., 211
 Heusner, G.L., 227
 Hildebrand, M., 38–40, 42–43, 47
 Hillidge, C., 68
 Hinchcliff, K., 126, 334
 Hindleg
 lift, 48, 50, 152, 205, 271, 341, 363
 stretch, 48, 59, 144–145
 Hintz, H.F., 108, 131, 137, 200, 225–226, 334–335, 340
 Hintz, R.L., 200
Hipparion, 6, 10–11
Hipparionini, 6, 10–11
Hippidion, 6, 10–11
 Hock, 8, 12, 372
 Hoffmann, R., 216
 Hohmann, M.E., 312
 Holdren, R.D., 131, 136
 Holland, J.L., 334
 Holmes, L.N., 334
 Home range, 35, 128, 182, 233–238, 240, 305–310, 317, 319–320
 Homing, 35, 237
 Hoof care, 335–336, 376
 Hormones, 164, 182–183, 185–186, 188, 192, 194–195, 384
 Horse care, 160, 327–384
 Horse evolution, 3–17

- Horse facilities, 81, 329–332
- Hoskins, R., 19, 22–23
- Houpt, C.E., 126
- Houpt, K.A., 25, 31, 74, 76–77, 80, 83–84, 86–87, 103, 107–108, 122, 126, 128–129, 136–138, 143, 158, 167, 190, 205, 208, 221, 225–226, 245, 248, 250, 269, 298, 301, 318, 323–324, 332–333, 337, 340, 346, 366–367
- Houpt, T.A., 122
- Houpt, T.R., 128, 332–333
- Housing, 273, 329–332, 340, 367, 380, 383–384
- Howell, C.E., 200
- Hoyer, J.H., 164
- Hoyt, D.F., 41
- Hubbard, R.E., 132–133, 135
- Hubbert, M.E., 138
- Hudson, R.J., 126, 133, 135, 313
- Hughes, A., 19–23
- Hughes, J.P., 184, 186, 193–196
- Hughes, R.D., 150, 310
- Human
- interaction, 68, 78, 80, 93, 97–98, 108–109, 139, 159–160, 201, 203, 206, 208, 237, 255–256, 259, 265, 269–271, 279, 284, 297, 299, 301, 332–333, 341–361, 384
 - socialization, 78, 112, 139, 204, 226, 231, 341–345, 366, 382 (see also Imprinting)
- Humburg, J.M., 172
- Hunter, L., 332
- Hurtgen, J.P., 195
- Hutchins, D.R., 353, 359
- Hybrid, 17
- Hyman, S.S., 364
- Hypermetria, 364
- Hyperparathyroidism, 376
- Hypoglycemia, 364–365, 378, 381, 383
- Hypohippus*, 6, 9–10
- Hypsodonty, 9
- Hyracotherium*, 5–10
- Ichikawa, F., 128, 331
- Imada, H., 101
- Imitation, 25, 96, 111, 158, 297
- Immigration, 215–217, 249
- Immobility, 352–355, 364, 370–371, 373–374, 377–381
- Impaction, 373, 382
- Impotence, 163, 168, 175–176, 368, 383
- Imprinting, 70, 77, 96, 111–112, 199, 226, 342, 382 (see also Primary Socialization)
- Inbreeding, 318, 325
- Incoordination, 364, 377–378
- Individual distance, 61–62, 125–126, 239–240, 251, 261, 330, 366 (see also Personal space)
- Individual recognition, 25, 31, 160, 205, 208, 221, 267, 298, 325
- Infanticide, 181, 261, 325, 368
- Infantilism, 383
- Infections, 39, 362, 364–366, 370–384
- Influenza, 377, 381
- Ingestive behavior, 70–74, 76, 80, 98, 124–143, 205, 334, 365–367, 379 (see also Feeding, Nursing, Drinking, Diet, and Food selection)
- Ingram, R.S., 103
- Inhalation, 59, 284, 299–300, 334, 381
- Insects, 38, 56, 71, 77, 126, 149–153, 157, 159, 233, 258, 271, 281–282, 306–307, 309–312, 371–373, 382
- Insight, 96, 110–111
- Interspecies attachment, 78, 112, 226, 231–232, 341–346, 350, 366, 382

- Intoxication, 377–378
 Intromission, 81, 89, 163, 165,
 167–170, 174–176, 179, 181,
 183, 368
 (see also Copulation)
 Investigative
 behavior, 25, 29–31, 48, 50, 54, 61,
 67–68, 70–71, 81, 87, 91–95,
 103, 133, 146–147, 173–174,
 190, 201, 206, 224, 227,
 253–256, 262–263, 267, 272,
 275–276, 299–301, 350, 364
 distance, 61
 Irritability, 271–272, 383
 (see also Ears laid back)
 Irvine, D.S., 194
 Ito, K., 128, 331
- Jackson, S.G., 125
 Jacobs, G.H., 24
 Janis, C., 9, 124
 Janzen, D.H., 34
 Jaw, 7, 12, 57–59, 119, 273, 354–355,
 362
 movement, 7, 9, 57, 80, 265, 267,
 279
 (see also Chewing and
 Snapping)
 Jaworowska, M., 182, 231, 248
 Jaworska, M., 129, 142, 146–147
 Jaworski, Z., 109
 Jeffcott, L.B., 146, 202
 Jelen, B., 129, 142, 146–147
 Jenkins, O.C., 333
 Jerky movements, 67, 92, 254–255,
 276, 371, 376, 378
 Jewett, T.K., 138
 Jezierski, T., 109, 129, 142, 146–147,
 167
 Jibbing, 48, 384
 (see also Balking)
 Jones, E.W., 361
 Jones, J.H., 338
- Jones, R., 111
 Jones, R.C., 4
 Jordan, R.M., 132
 Jousan, F.D., 338
 Jumping, 48–53, 84, 86, 110, 256,
 282, 329, 350
 Jussiaux, M., 269
- Kai, M., 125
Kalobatippus, 6, 9–10
 Kalz, B., 136
 Kaminski, M., 4, 17
 Kane, L., 84, 86–87
 Kapron, M., 129, 142, 146–147
 Kare, M., 31
 Kaseda, Y., 121, 129, 215–217, 320,
 322
 Keenan, M.A., 118, 121, 129, 138,
 159
 Keil, K., 23
 Keiper, R.R., 71, 93, 118, 121, 129,
 133, 135, 137–138, 150, 157,
 159, 200, 212, 215–216, 228,
 233, 236–237, 240, 243, 245,
 248, 252, 266, 308–311,
 317–318, 323–324
 Kelland, A., 111
 Keller, P., 19, 22–23
 Kenney, R.M., 172, 175, 178
 Keverling Buisman, A.K., 261
 Khalil, A.M., 320, 322
 Khur, 3–4, 14
 Kiang, 3–4, 14
 Kick threat, 48, 173, 206, 245, 257,
 260–261, 271, 279
 Kicking, 37–38, 48, 50, 54, 84–88,
 90, 143, 163, 178–179, 181, 183,
 186, 189, 205–207, 227, 245,
 255–257, 259, 261, 263–264,
 268, 279, 281–282, 301, 331,
 339, 351, 357–358, 367, 372, 384
 Kiguchi, A., 128, 331
 Kiley, M., 283

- Kiley-Worthington, M., 281, 309
 Kirkpatrick, J.F., 250, 323
 Kirschvink, J.L., 26
 Klingel, H., 270, 283
 Knight, H.D., 364
 Knill, L.M., 23
 Knocking, 48, 50, 54, 143, 152, 258, 271, 372
 Koch, W., 200, 316
 Koegel, A., 99
 Kokoszko, A., 338
 Kolter, L., 243, 245, 261, 331
 Kooistra, L., 193
 Kortz, G., 365
 Kosiniak, K., 168
 Kottenbelt, D.C., 365
 Kownacki, M., 129, 142, 146–147
 Kratzer, D.D., 103
 Kream, R., 368
 Kreider, J.L., 340
 Kristula, M.A., 138
 Kronfeld, D.S., 334
 Krysl, L., 138
 Krzak, W.E., 368
 Kubo, K., 125, 128, 331
 Kuhlers, D.L., 104
 Kulan, 4
 Kunkle, K., 128
 Kusunose, R., 72, 128, 140, 142, 222, 269, 331, 346
 Kyle, B., 126, 334

 Lady, 25
 Lagerweij, E., 354
 Lameness, 177, 335, 364–365, 372–373, 376
 Laminitis, 177, 179, 364, 373–374, 376–377, 381
 Lampas, 379
 Lane, J.G., 365, 368
 Laryngeal disorder, 381
 Lathyrism, 379
 Law, K., 245, 248
 Lawrence, L.M., 368
 Lawson, A.C., 26
 Lay, D.C., Jr., 331, 333
 Le Scolan, N., 346
 Leach, D.H., 40, 49
 Lead changes, 43
 Leadership, 206, 218, 251, 254–255
 Leahy, J.R., 353, 356–357, 360
 Learning, 15, 25, 60, 71, 91–92, 96–113, 126, 174, 250, 267–269, 335, 340–341, 344–353
 avoidance, 100, 103, 109, 349
 concept formation, 106, 110
 delayed reaction, 113
 detour problem, 101–102
 discrimination, 23–25, 27, 100, 102–109, 111, 113, 267, 348
 latent, 110
 maze, 100, 102–103, 108–109
 observational, 111
 social, 111
 trial and error, 35, 98, 101, 109, 111
 (see also Cognition, Conditioning, Extinction, Habituation, Imprinting, Imitation, and Training)
 Learning set formation, 104–107, 340, 348
 Leblanc, M.A., 107
 Leg, 5, 8, 11–12, 25, 37–38, 40, 42–43, 47–50, 54, 56, 58–59, 65–72, 77, 80, 82, 86–87, 89, 117–119, 121, 126, 129, 139–140, 144–145, 147, 150–153, 157, 165, 167–168, 170, 173, 184, 189–190, 201–205, 207, 229, 256–260, 262–265, 270–272, 274, 279, 281–282, 311, 335–336, 339, 341, 351, 356, 362–363, 372, 374, 376, 379
 damage, 331, 356, 364–365, 372–374
 restraint of, 66, 353, 357–359
 (see also Locomotion; Lameness)
 Lein, D.H., 200

- Lenarz, M.S., 130
 Lennon, A.M., 107, 346
 Lens, 19, 22–23
 Leonard, J.A., 14
 Leptospirosis, 379
 Lethargy, 204, 364, 373, 379, 383
 Levade, 48–49, 51
 Levine, M.A., 16
 Lewis, P., 108
 Libido, 164, 169, 172, 176, 178–179,
 188, 301, 368, 383
 Lice, 382–383
 Licking, 48, 57, 68, 91, 136, 140,
 150, 157, 159, 165, 201,
 203–205, 208, 220, 224, 267,
 300, 356
 Lidén, K., 14
 Lieb, S., 131
 Life
 range, 237
 span, 9, 11, 39, 214, 316, 322, 324
 Lindberg, A.C., 111
 Lindsay, F.E.T., 29
 Line, S.W., 172, 269
 Linklater, W.L., 72, 82, 188, 310,
 319, 321
 Lip, 11, 27–29, 39, 48, 57, 68, 80, 99,
 118–119, 124–125, 136–137,
 139, 153, 205, 265, 273–274,
 278–280, 297, 300, 354, 362, 364
 abnormalities, 362, 364, 370–371
 curl, 29, 58, 95
 (see also Flehmen)
 movement, 39, 48, 57, 125, 278,
 280, 364, 371
 Lishak, R.S., 104
 Listeriosis, 380, 383
 Littlejohn, A., 39, 56
 Liver malfunction, 364, 373, 383
 (see also Cirrhosis and Hepatitis)
 Loading, 336–338
 Locomotion, 11, 36, 38–47, 49, 60,
 68, 150, 227, 254, 256, 272, 275,
 278, 281, 299–300, 307,
 330–331, 335–336, 348, 357,
 364–365, 377
 Loins, 12, 150, 157
 Lokey, C.E., 102, 107–108
 Longevity (see Life span)
 Looking, 36, 48, 91, 136, 190, 201,
 205, 253, 262–363, 370
 (see also Stare)
 Lophiodonty, 8
 Love, C.C., 175
 Love, S., 384
 Lovell, G., 24–25
 Loy, R.G., 193–195
 Luescher, U.A., 368
 Lutherer, L.O., 333, 346
 Lying down, 48, 54–56, 69, 71, 117,
 311, 363, 373
 Lyme disease, 376
 Lymphangitis, 376, 379, 381

 McCall, C.A., 97–98, 103–104,
 108–109, 189, 243, 340, 345, 349
 McCann, J.S., 333, 346
 McClure, S.R., 368
 McCullough, D.R., 48, 72, 95, 121,
 133, 138, 146, 148, 157, 199,
 213–214, 219, 233, 237, 239,
 243, 250, 252, 255–256, 259,
 263, 267, 324
 McDonald, L., 368
 McDonnell, S.M., 48, 126, 138, 166,
 172, 175, 178, 253, 273,
 333–334, 368
 MacFadden, B.J., 3, 5–7, 9–11
 McFadden, W.J., 199–200
 McGorum, B.C., 365
 McGreevy, P.D., 111, 367–368
 Mackenzie, S.A., 346
 McKinnon, A.O., 183, 191, 195, 321,
 337
 McMahan, T.A., 41, 307
 McPheeters, G.M., Jr., 244
 Macuda, T., 25
 Maday, S. von, 272

- Mader, D.R., 107
 Madigan, J.E., 365
 Magne de la Croix, P., 42
 Mahaffey, L.W., 201–204
 Maher, J.M., 198
 Mahomet, 25
 Maintenance activities, 115–160, 237, 241, 248, 330, 362, 365, 379
 Mair, T., 384
 Mair, T.S., 365
 Mal, M.E., 108, 333, 345
 Malkas, P., 239, 258, 260, 266, 312, 325
 Malouf, N., 3
 Maltbie, M., 4
 Management, 17, 32, 65, 81, 132, 163, 172, 175, 181–183, 214, 229, 231, 273, 313, 327–384
 Mane, 12, 77, 86, 89, 153, 158, 259, 262, 270
 Mange, 372
 Marder, D.R., 96
 Marinier, S.L., 31–32, 76, 102, 107, 111–112, 125, 132, 301, 384
 Marking, 48, 145–148, 198, 239, 241, 246, 250, 263, 281, 301
 Marklund, S., 14
 Marlin, D.J., 338
 Marques, D.M., 29
 Marten, G.C., 132
 Martinisi, V., 245, 247
 Martin–Rosset, W., 126
 Marwick, C., 78, 341
 Mastication, 37, 124, 379
 (see also Chewing)
 Masturbation, 48, 152–153, 166–167, 176–178, 384
 Mate preference, 15, 81, 112, 176–177, 189, 229, 325, 368
 Maternal behavior, 82, 199–208, 218, 220–224, 268, 321
 Mathes, E.W., 346
 Matthews, R.G., 183, 199–200
 Mayes, E., 126
 Mayhew, I.G., 362, 384
 Meacham, T.N., 334
 Meckley, P.E., 175
 Melioidosis, 376
 Memory, 34–35, 96–97, 103, 106, 109, 113, 221, 268
 Meningeal disease, 364, 378
 Meredith, M., 29
 Merritt, A.M., 362, 384
Merychippus, 6–7, 9–11
 Mesker, D.C., 101
Mesohippus, 6–8, 10
 Metacarpals, 8, 12–13, 376
 Metacommunication, 301
 Metatarsals, 8, 12–13, 376
 Mezair, 48–49
 Migration, 309–310
 Miller, E., 111
 Miller, R., 211, 215–216, 218, 238–239, 251–252, 305, 309, 319
 Miller, R.M., 352
 Mills, D.S., 332, 349, 368
 Minett, F.C., 29
 Minot, E.O., 82, 188, 310
 Mintscheff, P., 196
Miohippus, 6, 8–10
 Mites, 382
 Miyashita, Y., 101
 Moens, Y., 24
 Mogi, K., 215, 217
 Molarization, 8, 124
 Montgomery, G.G., 245, 248
 Moore, J.N., 362, 384
 Moore, S., 19, 22–23
 Morphology
 body, 5–9, 11–13
 eye, 18–23
 Morrison, M.L., 310, 325
 Mortality, 214, 316, 321, 324
 Mosley, J.C., 321
 Moss, F.P., 199–200
 Motion sickness, 380

- Motor coordination, 38–39, 50,
 68–69, 77, 139, 141, 301, 336,
 361, 364, 375–378
 Mounting, 38, 48, 80–81, 86–89,
 163–175, 177–179, 181, 186,
 188, 190, 196–198, 216, 230,
 240, 282, 317, 368
 Mouth movements, 37, 57–59, 71, 76,
 80, 83–84, 99, 124, 136, 139,
 150, 167, 259, 265, 273, 277,
 279–280, 283, 297, 300, 380
 Movement patterns, 36–62, 65–67,
 80, 84, 89, 92, 120–121, 126,
 139, 150–158, 202–203, 224,
 233, 240, 264, 267, 271–282,
 309–311, 362–365, 370–371,
 374, 378
 Mucormycosis, 364, 378, 381
 Muhamed, 25
 Müller, W., 33
 Munaretto, K.R., 298
 Munk, O., 19
 Munro, R., 56
 Murphy, C., 365
 Murray, M.J., 365
 Mutual grooming, 48, 77, 87–89,
 157–159, 166, 190, 206–207,
 218, 222–223, 227, 229–230,
 242, 251, 267, 300, 330
 (see also *Allogrooming*)
 Muzzle, 8, 11–12, 56–57, 67, 87,
 91–92, 99, 126, 139, 152, 184,
 201, 255, 263, 297, 300, 354, 371
 Mycosis, 364–365, 375–376, 378–382
 Myelitis, 364, 370–371, 373–378, 380
 Myers, R.D., 101
 Myopathy, 376

 Nachreiner, R.F., 172
 Naden, J., 170
 Nagata, Y., 125
 Nakajima, S., 101
 Nankervis, K.J., 349

Nannippus, 6, 10–11
 Nasimovič, A.A., 16
 Nasogenital contact, 48, 165, 168,
 190, 301
 Nasonasal contact, 25, 48, 95, 185,
 263, 275, 300–301
 Navicular disease, 269, 374
 Neck, 12, 29, 36–41, 48, 50, 54,
 56–58, 60, 67, 71, 77, 80, 87,
 94–95, 118–119, 139, 141,
 152–153, 157–158, 165,
 167–168, 189–190, 196, 220,
 245, 253–259, 261–263,
 270–277, 281, 297, 300, 331,
 336, 341, 347, 356, 362, 365, 372
 movement, 19, 37–41, 47, 50,
 56–58, 60–61, 66–67, 92, 94,
 118, 125, 139, 144, 149,
 151–153, 165, 167–168,
 254–256, 259, 262, 265, 273,
 277, 336, 341, 362, 365
 Neely, D.P., 193
 Negi, G.C.S., 125, 305
 Neigh (see *Whinny*)
 Nelis, P.C., 354
 Nematodosis, 376–377
Neohipparion, 6, 10–11
 Neonatal maladjustment syndrome,
 78, 364–366, 371, 375, 278,
 380–382
 Nervousness, 26, 136, 254–256, 272,
 361, 373, 384
 Netherland, W.M., 103
 Nett, T.M., 172
 Neural damage, 362–364, 370–371,
 373, 378–379, 381
 Neuroendocrine, 164, 315
 disorder, 383
 (see also *Tumor*)
 Newland, M.C., 108
 Newton, S.A., 365
 Nibbling, 48, 57, 71, 77, 84–89, 91,
 150–151, 157–159, 165, 170,

- 184, 204–205, 226–227, 229,
231, 267, 300, 348
- Nicker, 48, 141, 165, 201–202, 206,
220, 224, 254, 283–284,
287–289, 297–298
- Nicol, C.J., 111, 367–368
- Nicolas, E., 19
- Nictitating membrane, 58–59, 265,
370
- Nipping, 7, 48, 71, 80, 83, 150, 165,
205, 216, 258, 269, 317
- Nishikawa, Y., 169, 172, 193
- Nobbe, D.E., 104, 113
- Nobis, G., 15
- Nockels, C.F., 321, 337
- Nodding, 47–48, 58, 259, 272, 297,
368, 372
- Noden, P.A., 186, 188, 195
- Normile, J.A., 269
- Nose, 18, 25, 27, 34, 36–37, 50, 58,
67, 104, 174, 206, 341, 370
- Nostril, 60, 206, 254, 263, 273, 278,
297, 299, 362, 381
dilation, 39, 253–254, 273,
275–277, 297–299, 365, 381
flared, 48, 60
- Nozawa, K., 215, 217
- Nugent, E., 361
- Nursing, 48, 68–74, 78, 81–82, 91,
124–125, 139–143, 205,
207–208, 222–224, 265, 283,
300, 311, 317, 321
- Nutrition, 18, 82, 104, 160, 182, 196,
199–200, 208, 308, 330,
334–335, 368
- Nutritional deficiency, 192, 196, 316,
324, 350, 362, 366, 370–384
- Obstinace, 205, 268, 344, 352–353
- Obstructions, 378
esophageal, 365, 372, 380
respiratory, 365, 381
urinary, 365, 382
- O'Connell, M.F., 122
- O'Connell, R.J., 29
- Ocular disease, 365
- Ödberg, F.O., 26, 39, 50, 130, 147,
189, 271–272, 298
- Ogawa, H., 322
- Oki, H., 331
- Okuda, Y., 125
- Olberg, G., 231
- O'Leary, L., 137
- Olsen, F.W., 133, 135
- Onager, 3–4, 14, 17
- Onohippidium*, 6, 10–11
- Ophthalmia, 364, 370, 374
- Opisthotonus, 378
- Oppegard, C., 109
- Orientation, 18–19, 26–27, 34–35, 37,
50, 62, 67–68, 70, 80, 92, 95,
145, 149, 224–225, 253–254,
260, 273–275, 277–278, 281,
298, 337–339, 345, 362–364,
368, 375
- Ormrod, K., 49
- Orohippus*, 6, 8, 10
- Osslets, 376
- Osteitis, 365
- Osteoarthropathy, 376, 380
- Ostlund, E.N., 364
- Otolith, 32, 34
- Ott, E.A., 131
- Ovarian malfunction, 198, 269,
383–384
- Ovulation, 183–186, 188–189,
191–196, 199, 315
- Oxender, W.D., 186, 188, 195
- Pace, 42–43, 45, 47–48
stepping (see Slow gait)
- Pacheco, M.A., 211
- Pain, 33–34, 175, 177, 179, 208,
221–222, 268–269, 271, 282,
353, 361, 363, 365, 368, 372,
374, 376–377
- Paleotheres, 6, 9
- Palmer, J.E., 364

- Parahippus*, 6, 9–10
 Paralysis, 178, 364, 370–371, 374–375, 377–381
 Parasites, 133, 159, 311–312, 330, 362, 365–366, 371–373, 376, 378–379, 382–384
 Parental care, 199, 223, 226, 237, 324 (see also Maternal behavior)
 Parker, W.G., 194
 Parsons, M.S., 108
 Parturient behavior, 31, 38, 67, 82, 112, 123, 159, 183, 195, 199–208, 220–222, 272, 300
 Parturition, 48, 65, 199–205, 315–316, 382
 Pascoe, J.R., 338
 Passage, 48–49
 Pasture, 122–124, 128, 130, 142, 147, 196, 244, 313, 330–331, 367–368
 Pastern, 12, 357
 Patel, J., 367
 Patella, 12
 luxation, 376
 Pattie, W.A., 175
 Payne, C.T., 4
 Pawing, 39, 48, 50, 54, 76, 84–85, 87, 126, 133, 137, 147, 153, 184, 186, 201, 204–205, 254, 262–263, 272, 339, 363, 372
 Pellegrini, S., 138, 234–236, 238
 Pelvic thrust, 48, 80, 163, 167–168, 170, 175, 179
 Penick, J., Jr., 26
 Penis, 89, 145, 166, 168, 174, 178, 373
 erection, 48, 153, 165–166, 168, 170, 230, 281
 extension, 48, 165–166, 178, 361
 retraction, 48, 168
 Perception, 18–35, 61, 221, 268, 362, 364, 374–375
 auditory, 26–27, 276, 264, 374
 chemoreception, 28–32, 221, 364, 375
 pain, 33–34
 pressure, 28
 proprioception, 32
 tactile, 27–28
 temperature, 28
 visual, 18–25, 374
 Perceptive distance, 61
 Perinychium, 66
 Peritonitis, 373, 382
 Perkins, A., 250
 Personal space, 61–62, 239, 308
 Petersson, K., 137
 Pfaffenberger, C.J., 341
 Pfungst, O., 25, 271
 Pharyngeal disorder, 379–381
 Pheromone (Homotelergone), 29–31, 34, 146–147, 165, 168, 189–190, 204–205, 221, 263, 301
 Physiological characteristics
 digestion, 9, 124, 334
 estrous cycle, 183–196
 excretion, 38, 76, 144–148
 foal, 32–33, 37–39, 65–77, 139–140, 146–147
 reproduction, 164–165, 182–186, 188, 191–205, 316, 320–324
 sleep vs. alert wakefulness, 120–123
 Piaffe, 48–49, 54, 272
 Pica, 133, 136, 330, 363, 366–368, 384
 Pick, D.F., 24–25
 Pickerel, T.M., 189
 Pickett, B.W., 164, 168–172, 174–176, 178–179, 181, 191, 195
 Pineda, M.H., 194
 Pirie, M., 29
 Pirouette, 48–49
 Pisa, A., 20–21
 Pitts, C., 349–350
 Placenta, 70, 203–205, 208, 224, 299
 Play, 70–71, 80–81, 83–90, 92, 100, 206, 218–220, 222, 227–229, 261, 301, 345
 fighting, 87–90, 227, 230–231, 259, 268, 276

- Pleasure, 273, 278, 280
 Pleuritis, 377
Pliohippus, 6, 10–11, 13
 Plotka, E.D., 323
 Plumb, G.E., 138
 Pluth, D.J., 133
 Pneumonia, 380
 Podliachouk, L., 4
 Poisons (Poisoning), 32, 364, 366, 370–371, 373–382
 (see also Toxins)
 Pollitt, C.C., 66
 Polydipsia, 380
 Poplawski, L.J., 98
 Popov, N.F., 108
 Popper, A.N., 26
 Population dynamics, 213–214, 234–235, 241, 306, 313, 320, 322–325
 Potter, G.D., 103–104, 111, 243, 329, 340, 348
 Powell, D.M., 323
 Powell, R.P., 246–247, 251
 Prachoff, R., 196
 Prahov, R., 195
 Prancing, 42, 48, 165, 272
 Pratt, R.M., 132
 Predation, 18, 24, 305, 310, 323–325
 Pregnancy, 81, 128, 182–183, 197–200, 252, 307, 315–316, 322–325
 Presenting, 48, 81, 139, 185, 196, 252
 Pressure, 27–28, 37–38, 117, 174, 275, 336–337, 341, 349, 353–355
 Price, E.O., 96, 107, 334
 Primary socialization, 70, 77–78, 112, 341, 366
 (see also Imprinting)
 Prince, J.H., 21, 23
 Problem behaviors, 111, 136, 176–179, 268–269, 331, 336–337, 350–352, 366–368, 383–384
 Proprioception, 32
 Prostration, 378
 Protectiveness, 61, 204, 206, 208, 218, 220, 222–223, 227, 231, 268, 310
Protohippus, 6, 10–11
 Pruski, W., 17
 Przewalski's horse, 3–4, 14, 16, 84, 138, 261, 330
 Pseudocyesis, 383
Pseudohipparion, 6, 10–11
 Puberty, 81, 170, 172, 182, 217, 230–231, 317–318, 325
 Pulse, R.E., 103
 Purohit, R.C., 172
 Purpura, 373, 377
 Pushing, 48–49, 54, 57, 66, 83, 87, 99, 108, 126, 141–142, 245, 256–257, 262–263, 277, 279, 301, 367
 Putman, R.J., 132
 Quidding, 379
 Rabies, 364, 366, 373, 378, 380, 383
 Rack, 42, 46–48
 Radinsky, L.B., 6–7, 11
 Radtke, K., 368
 Ralston, S.L., 126, 131–132, 137, 191, 321, 337, 366
 Ram, J., 125, 305
 Ramsey, C.B., 108
 Rand, W., 269, 368
 Randall, R.P., 31, 132
 Rank, 103, 109, 228, 240, 243–251, 316, 318–319, 352
 (see also Dominance)
 Rapid eye movement (REM), 120, 167
 Rasbech, N.O., 179–180
 Reactive distances, 60–62, 330, 341
 Rear threat, 88, 173, 183, 206, 245, 257, 260–261
 Rearing, 48–53, 83, 87, 89–90, 167, 227, 256, 259–260, 263, 279, 345, 366, 373, 384

- Recognition, 25, 31, 205, 208, 221, 298, 325
- Recumbency, 54–56, 59, 66, 70, 74, 89, 117–123, 149, 153, 159, 201–206, 220, 224, 227, 253, 299–300, 309, 330–331, 352, 359–361, 364, 376
- lateral, 48, 55–56, 71, 74, 117, 119–121, 123, 140, 167, 201–202, 274, 299, 344,
- sternal, 38, 48, 55–56, 66, 68, 71, 74, 91, 117–123, 139, 152–153, 201–202, 274
- Redirected behavior, 198, 261, 268–269
- Reed, L.C., 70
- Reflexes, 36–38, 40, 66, 255, 341, 360, 364
- abdominal cutaneous, 37–38
- bucking, 37
- cervico-auricular, 36–37
- corneal, 37, 360, 375
- cough, 37
- ejaculatory, 37–38
- head shake, 36–37
- kicking, 37–38
- labyrinthine, 37–38
- lacrymal, 36–37
- local cervical, 37–38
- mastication, 37
- palpebral, 36–37, 360
- panniculus, 37–38
- perineal, 37–38
- Pryer, 26, 36–37
- pupillary light, 36–37, 67
- salivary, 37
- segmental static, 37–38
- sneeze, 37
- spinal visceral, 37–38
- sucking, 37, 68, 70, 91, 139, 365, 380
- sway, 37
- thrusting, 37–38
- tonic eye, 36–37
- tonic neck, 37
- vertebra prominens, 37
- vestibular, 37
- visual blink, 37
- withdrawal, 37–38
- Regurgitation, 144
- Reilly, L.K., 364
- Reinforcement, 98, 100–101, 104, 106, 108, 110, 272, 336, 341–342, 348–352
- Renver, 47–48
- Reproductive behavior, 161–208, 226 (see also Sexual behavior)
- Reproductive success, 15, 172, 176, 188, 252, 315, 318–323, 333
- Respiration, 33, 66, 117, 120, 144, 168, 276, 360, 365, 381
- Respiratory disease, 364–365, 379–381
- Resting, 6–8, 19, 34, 56, 59, 65, 69, 73–75, 81, 91, 110, 117–124, 128, 141–142, 146, 149–150, 166–167, 222, 227, 229–230, 246, 253, 308, 311, 330, 365, 373, 376 (see also Sleep)
- Restless, 68, 70, 136, 183, 200–201, 204, 225, 232, 254, 269, 272, 299, 330, 337, 351, 353, 367, 373, 380, 384
- Restraint, 33, 39, 66, 77, 208, 256, 269, 272, 340–341, 345, 352–361
- Retina, 19–24, 27
- Rhine, J.B., 25
- Rhine, L.E., 25
- Rhinitis, 365
- Rhythmicity, 71, 117, 123, 166, 168, 173, 191, 237, 281, 362, 364
- Richards, W.P.C., 195
- Richardson, J.D., 368
- Ricketts, S.W., 184, 191, 194, 196, 198, 201, 204–206
- Rifá, H., 222
- Righting response, 38, 66, 70 (see also Reflexes, labyrinthine)

- Rikhari, H.C., 125, 305
 Ritualization, 261–262, 264, 267, 301
 Robertson, V., 338
 Rodger, L., 365
 Rolling, 48, 54–57, 71, 77, 89, 148, 153–156, 201–202, 204–205, 246, 250, 272, 282, 312, 363, 365, 373
 Rollins, W.C., 200
 Rooney, J.R., 36–37, 40–41, 341, 364
 Ropiha, R.T., 185, 199–200
 Rose, R.J., 353–354
 Rossdale, P.D., 33, 66–69, 78–79, 139, 184, 187, 191, 194–206, 224, 365
 Roughage, 57, 98–101, 104, 121, 125–126, 129, 131, 136, 204, 309, 330, 334–335, 367–368, 384
 Rubbing, 48, 54, 56–57, 71, 77, 149, 151–153, 166, 269, 278, 312, 335, 347, 353, 365, 382
 Rubenstein, D.I., 129, 234–235, 237, 240–242, 264, 284, 301, 308, 312
 Rubin, L., 109
 Ruckebusch, Y., 117, 120–123
 Rudman, R., 103, 250, 310
 Running walk, 42, 46–48
 Rupture
 bladder, 365, 374, 382
 fetal membranes, 65–66, 201–202
 large intestine, 381
 muscle, 372
 stomach, 364, 377–378
 tendon, 372
 Ruskell, G.L., 21, 23
 Rutberg, A.T., 216, 246–247, 311, 317–318, 320
 Ruvinsky, A., 3
 Ryder, O.A., 3–4, 13–14
 Sacking out, 347
 Safety, 42, 230, 255, 269, 329–332, 336–337, 350, 353, 361
 Salivation, 37, 380
 Salt ingestion, 31–32, 132–133, 136, 365, 373–374, 378, 381
 Salter, R.E., 126, 128, 133, 135, 200, 211, 216, 228, 234–236, 238, 248, 250, 252, 262, 313
 Salters, M.A., 109
 Sambraus, D., 226
 Sambraus, H.H., 226, 248, 252, 368
 Sanctuaries, 150, 310–311
 Sandberg, K., 14
 Sanders, L., 172, 269
 Sappington, B.K.F., 104
 Sasimowski, E., 129, 142, 146–147
 Sawazaki, H., 72, 140, 142, 222
 Schäfer, M., 17, 265, 270, 298
 Schaffer, J., 302
 Schemnitz, S.D., 313
 Schiebe, A., 136
 Schiebe, K.-M., 136
 Schneider, K.M., 58
 Schoen, A.M.S., 88, 142, 259
 Schott, H.C., II, 126, 334
 Schryver, H.F., 131
 Schumacher, E.M.A., 194
 Schumacher, J., 384
 Schurg, W.A., 31, 132
 Scott, A.M., 325
 Scott, J.P., 341
 Scratching, 48, 54, 71, 77, 149, 151–152, 158, 227, 278, 312
 Seamans, K.W., 193
 Sedatives, 361
 Seidel, G.E., Jr., 169–171
 Seiferle, E., 33
 Self-mutilation, 268–269, 366, 368
 Semicircular canal, 32–34
 Sensitive period, 78, 82, 111–112, 199, 221, 341, 344, 366
 Sensitivity, 22, 27, 60, 139, 175, 194, 205, 324, 374
 Septicemias, 365, 379–380
 Sereni, J.-L., 245
 Seunig, W., 49–50
 Seweryn, A., 129, 142, 146–147

- Sex ratio, 7, 213
- Sexual behavior, 29, 80–81, 229–230,
324–325, 366, 368
female, 182–198
male, 89, 163–181, 297, 302
(see also Reproductive behavior)
- Sexual maturity, 81, 170, 182,
230–231, 315–318, 325
- Shaking, 48, 56, 77, 145, 149, 151,
153–157, 276, 281–283, 300,
312, 365, 371
- Shaping, 101, 104, 348, 350
- Sharp, D.C., 193–194
- Shelter seeking, 70–71, 142, 149–150,
223–224, 261, 265, 307,
309–312, 332, 373
- Shideler, R.K., 198
- Shivering, 48, 150, 373, 377
- Shoeing, 336
- Short, R.V., 4, 201
- Shoulder-in, 47
- Shuster, L., 269, 367–368
- Shying, 48, 256, 267–268, 333, 364,
366, 384
- Siegmund, O.H., 144, 364–365,
384
- Sigurjónsdóttir, H., 228
- Simpson, G.G., 5, 7, 23
- Simpson, S.M., 109
- Singh, S.P., 125, 305
- Siniff, D.B., 323
- Sinohippus*, 6, 9
- Sisson, S., 23, 28–29, 31, 60, 165
- Sitting, 363, 374
- Sivak, J.G., 19, 23
- Skelton, K.V., 194
- Skiff, E.M., 330
- Skin twitching, 38, 48, 56, 153,
281–282, 312
(see also Reflexes, panniculus)
- Skorkowski, E., 14
- Skull, 7, 9, 11–12, 17–18, 32, 257,
277, 378
- Slade, L.M., 349
- Sleep, 48, 70–71, 117–123, 149, 167,
273–274, 309, 361
- Slow gait, 42, 46–48
- Smacking, 48, 57, 205, 283, 300
- Smelling, 28–32, 48, 91–92, 140,
146–147, 165, 190, 205, 221,
253, 263, 301, 347, 375
(see also Sniffing)
- Smith, B.L., 338
- Smith, M.A., 138
- Smith, R., 143
- Smith, S., 25
- Smithcors, J.F., 36, 353, 384
- Snake bite, 374, 378–379, 381
- Snaking, 48, 60, 259, 277, 279
- Snapping, 48, 57, 71, 80–81, 89, 190,
250, 259, 265–267, 273,
279–280, 283, 300
- Sniffing, 48, 54, 58, 68, 76, 87, 91,
94–95, 147, 157, 165, 168, 170,
184, 204–205, 216, 221, 224,
227, 229, 263–264, 267, 273,
275, 284, 294, 299, 301
(see also Smelling)
- Snook, C.S., 364
- Snore, 48, 283–284, 296, 299–300
- Snort, 283–284, 295, 299
- Social
abnormalities, 175–181, 196–198,
208, 269, 363, 382–383
attachment, 15, 77–78, 112, 203,
219–232, 237, 239–240, 245
behavior, 15, 35, 78, 144, 209–302,
315–325, 363, 366
distance, 62, 218, 220, 233,
237–238
dominance, 153, 240, 243–252
(see also Dominance)
facilitation, 126, 218, 250, 274
needs, 211–213, 215–232, 332–333
organization, 211–218
roles, 217–218
- Soemmerring, D.W., 19–20
- Soil ingestion, 133, 384

- Soliciting (see Presenting)
- Solmka, Z., 129, 142, 146–147
- Solounias, N., 9
- Sondaar, P.Y., 5, 7–8, 11, 38
- Song, G.K., 334
- Sounds, 26–27, 36, 57, 67–68, 70,
91–92, 98, 108, 121, 173, 189,
224, 253–254, 265, 272, 274,
279, 283–300, 310, 333, 348, 374
(see also Vocalization)
- Sowell, B.F., 138
- Spasms, 364, 372, 374, 378
- Spavin, 376
- Spector, W.S., 144
- Spectrograms, 283–298
- Speed, J.G., 14
- Spermatic cord, 382
- Splint bone, 11–13
- Splints, 376
- Spring ligaments, 39
- Squeal, 48, 70, 139, 173, 183–184,
186, 189, 205, 257, 262–263,
283–286, 296, 298
- Squires, E.L., 164, 170, 172,
174–176, 178–179, 181, 183,
191, 195, 198, 321, 337
- Stabenfeldt, G.H., 183–184, 186, 193,
196
- Stable, 85, 99, 330–333
- Stafford, K.J., 72, 82, 188, 310, 321
- Staggering, 364, 377
- Stall, 65, 68, 73, 78, 85, 91, 98–99,
121–123, 126, 136, 141–142,
189, 331–332, 342, 367–368
walking, 367, 384
- Stamping (see Stomping)
- Standing, 5, 24, 39, 48, 54, 59,
66–70, 73–74, 91, 117–120, 122,
126, 136, 139–141, 152, 157,
166, 186, 189, 201, 203–205,
207–208, 220, 227, 262, 272,
274–275, 282, 299, 309, 311,
351–352, 359–360, 379
- Stanley, W.C., 341
- Stare, 48, 227, 255, 262, 265, 363, 370
- Static accommodation (see
Accommodation)
- Stebbins, M.C., 248–250, 252
- Steinhart, P., 117, 120
- Stern, F.L., 29
- Stevenson, S.M., 283, 297, 299
- Stiffness, 364, 377
- Stifle, 12, 50, 139, 152, 205
- Stimulus, 29, 31, 33–34, 36, 38,
60–61, 92–93, 97, 253–255, 268,
271, 278, 281, 336, 346, 348–351
conditioned, 97, 106–108
unconditioned, 103, 108
- Stinson, A.W., 27–28
- Stomatitis, 371
- Stomping, 48, 50, 152, 258, 271, 372
- Stowe, H.D., 132
- Strangles, 372, 379–380
- Streich, J., 117, 136
- Stress, 33, 117, 191, 214, 227, 237,
269, 276, 321, 325, 336–337,
340, 344, 365
- Stride, 40–43, 47, 281, 307, 376
- Strike
distance, 61
threat, 48, 257–258, 262–263
- Striking, 48, 50, 54, 84, 86–87, 181,
183, 204, 245, 255–259,
262–264, 268, 271, 279,
281–282, 301, 384
- Stringhalt, 376
- Stud pile, 133, 146–148, 250,
262–263
- Studiencow, A., 191
- Stumbling, 364, 377
- Submission, 57, 61, 89, 223, 231,
243–248, 250, 253, 259,
264–267, 280–282, 352
- Submissive distance, 61
- Sucking, 37, 48, 57, 68, 70, 72–73,
82, 91, 136, 139–143, 261, 265,
279, 300, 317, 321, 365, 380
(see also Nursing)

- Sufit, E., 136–137
 Sullivan, J.J., 194
 Sunning, 48, 119, 149
 Supplant, 48, 230, 240, 245
 Surra, 378
 Sutherland, T.M., 168–170
 Suzuki, Y., 224
 Swafford, B.C., 39
 Swallowing, 48, 57, 99, 125–126, 136–137, 144, 365, 380
 Swan, S.M., 194–195
 Swartzman-Ardert, J.A., 107
 Sweating, 33, 144, 150, 200–201, 205, 276, 365, 381
 Sweeney, 372
 Sweeting, M.P., 126, 136–137
 Swimming, 48–49, 71
 Symbiotic relationships, 159–160, 305, 311–313
 Symptoms, 362–367, 370–384
 changes in expression and posture, 362–364
 changes in maintenance behavior, 365
 changes in motor coordination, 364–365
 changes in orientation, 364
 changes in perception, 364
 changes in social behavior, 366
 Tail, 5, 12, 38, 80, 86, 89, 136, 152, 157–158, 270–272, 281–282, 357–359, 362–364, 372–373, 378
 depression, 48, 60, 66, 265, 281
 flagging, 48, 168, 201, 281
 movements, 60, 71, 281
 raising, 48, 60, 69, 144–145, 147, 170, 173, 184, 186–187, 189–190, 201, 254, 262, 272, 275, 281
 switching, 48, 60, 77, 145, 147, 151, 157, 159, 183, 186, 257, 262, 281–283, 300, 309, 311–312
 Takh, 4
 Talbot, R.B., 191
 Talukdar, A.H., 27–28
 Tapetum lucidum, 22
 Tarpan, 16
 Taste, 28, 31–32, 34, 107, 131, 255
 buds, 28, 30–31
 Taxonomy, 3–4, 16
 Taylor, C.R., 41, 307
 Taylor, E.L., 130
 Teeth, 5, 7–9, 11–13, 28, 57, 80, 99–100, 124–125, 150–151, 261, 265, 279, 297, 354–355, 371
 Teeth clapping (see Snapping)
 Telegin, D.Y., 16–17
 Temperament, 14, 17, 249, 333, 346–347, 360, 363, 383
 Temperature, 66
 Temple, J.L., 366
 Territoriality, 233–234, 238–342, 305, 308
 Territory, 234, 240–342, 308
 Tester, J.R., 323
 Tetanus, 363–364, 370, 372, 374–375, 377–378
 Thermoreception, 28
 Thermoregulation, 307
 Thiboutot, E., 346
 Thigh, 12, 54, 157, 165
 Thirst, 136–137, 380
 Thompson, D.L., Jr., 172
 Thórhallsdóttir, A.G., 228
 Thrombosis, 376
 Timney, B., 23, 25
 Time-budgets, 73, 123, 308–309, 324
 Tischner, M., 167
 Tobin, T., 361
 Toe, 5, 8–9, 11, 13, 38, 50, 376,
 Tokimi, A., 125
 Tolt (see Rack)
 Tomica, E., 167
 Tongue, 12, 30, 37, 57, 68, 139, 265, 362, 371
 movement, 48, 57, 371

- papillae, 30–31
- rolling, 48, 57, 371
- utilization, 7, 57, 92, 124–125, 139
- Tool use, 84, 100
- Touch, 27–28, 34, 36–38, 67–68, 87, 92, 97, 101, 108, 139, 152–153, 163, 174, 184–185, 189, 227, 256, 270, 274–275, 278, 283, 300–301, 342, 348
(see also Perception)
- Touchberry, R.W., 322
- Toxicosis, 366, 374,
- Toxins, 362, 364–365, 370–383
(see also Poisons)
- Toxoplasmosis, 378
- Tractability, 160, 276, 301, 333, 344, 346
- Training, 42, 50, 92, 96–98, 104–106, 108–110, 113, 269, 331, 333–334, 337, 340–341, 343, 345–353
(see also Counterconditioning, Desensitizing, Flooding, Learning, Memory, and Shaping)
- Tranquilizers, 178, 361
- Transfusion reaction, 373
- Transport, 191, 321, 336–339
- Trauma, 39, 113, 172, 175, 178, 196, 208, 350, 362, 370–383
- Traver, 47–48
- Trembling, 377
- Tremors, 33, 364, 371, 378
- Trexler, P.C., 68
- Tricker, B.J.K., 41
- Tricker, R.A.R., 41
- Trillard, C., 269
- Trot, 41–44, 47–49, 70–71, 110, 165, 255–256, 262, 272, 282, 307, 333, 376
- Trotter, G.W., 173
- Trum, B.F., 191
- Trumler, E., 298
- Tschanz, B., 163, 213, 215–217, 228, 262
- Tuberculosis, 372
- Tularemia, 373, 379–380
- Tumor, 196, 198, 269, 373–374, 379–380, 382–384
- Turner, J.W., Jr., 250, 310, 323, 325
- Two tracking, 47–48
- Tying-up, 377, 381
- Tyler, S.J., 68, 71–77, 79–81, 86–89, 117, 121, 128–130, 132–133, 141–143, 146–148, 152, 158–159, 166–170, 181, 190, 200–201, 204–207, 215, 218–219, 221–223, 226–227, 229, 231, 236–238, 245, 247–251, 261, 265, 267, 298, 325, 368
- Umbilical cord, 66, 203–204
- Unterlegenheitsgebärde (see Snapping)
- Urination, 48, 69–71, 76, 81, 144–146, 148, 165, 173, 178, 184–186, 190, 196, 201, 250, 281–282, 339, 365, 382
- Urine, 29, 31, 81, 95, 130, 144–146, 173–174, 189–190, 239, 281, 301–302, 360, 382
(see also Urination and Marking)
- Urticaria, 379
- Van Arsdalen, K.N., 178
- Van Asten, G.S., viii
(see also Dark, G.S.)
- Van den Broek, G., 126
- van Dierendonck, M., 228
- van Gerven, A., 22
- Van Niekerk, C.H., 196
- van Ree, J.M., 354
- Van Vleck, L.D., 200
- van Weeren, R., 261
- Vandeplasseche, M., 179
- Vaughan, J.T., 354, 359
- Vavra, M., 138, 305–306
- Veeckman, J., 177, 189

- Veltman, C.J., 72, 321
 Verga, M., 67, 200–201, 204
 Vertigo, 364, 375
 Vestibular system, 32–33, 37, 40, 341
 lesion, 375, 377
 Vices (see Problem behaviors)
 Viciousness, 181, 261, 325, 368,
 383
 Victoria-Troncoso, V., 22
 Vigne, N., 159
 Vilà, C., 14
 Virga, V., 205
 Vision, 18–25, 27, 34, 91, 95
 color, 24–25
 impairment, 364, 370, 374,
 376–377, 384
 nocturnal, 22
 Visser, E.K., 346
 Vocalization, 25–26, 33, 67, 70–71,
 80, 121, 185–186, 189, 196, 202,
 224–225, 231, 257, 264, 276,
 283–299, 338–339, 342
 Vogelsang, S.G., 333
 Voith, V.L., 97, 105–106, 173, 349,
 351
 Volf, J., 4
 Volvulus, 382
 Vomeronasal organ, 28–31
 Voss, J.L., 169–171, 174–176,
 178–179, 181, 191, 195, 198

 Waggoner, J.W., Jr., 138
 Wainer, M., 61
 Waiting, 48, 138, 231, 237–238, 250,
 318, 345
 Walk, 39, 41–43, 47, 68–71, 89, 110,
 118, 147, 152, 205, 207, 226, 253,
 256, 276, 282, 297, 307, 311, 337,
 343, 348, 357–358, 367, 370,
 372–373, 375–376, 384
 diagonal, 42, 44, 48
 lateral, 42, 44, 48
 Wallach, S.J.R., 164, 191
 Walls, G.L., 22

 Walser, K., 33, 201, 363
 Walton, A., 168
 Wandering, 217–218, 230–231, 320,
 364
 Waran, N.K., 337–338
 Waring, G.H., 20, 57, 60–61, 66–68,
 70–71, 73, 79, 92, 96, 98, 100–101,
 112, 126, 142, 168–169, 220, 224,
 238, 273–280, 282–296, 341–343,
 366
 Warnick, A.C., 170
 Warren, H.B., 104
 Warren, J.M., 104
 Watson, E.D., 193, 384
 Wayne, R.K., 14
 Weakness, 364, 379, 382
 Weaning, 81–82, 141, 207, 222,
 340
 Weaving, 48, 58, 111, 272–273, 363,
 366–368, 384
 Weeks, J.W., 227
 Wellington, J.L., 29
 Wells, S.M., 72–73, 81–82, 88,
 158–159, 228, 245, 247–249,
 259, 267, 321
 Welsh, D.A., 121, 137, 200, 211, 214,
 216, 218, 234–238, 250, 263,
 308, 319
 West, C.D., 26
 West Nile virus, 364
 Whinny, 48, 70, 165, 224, 229, 262,
 283–284, 290–291, 297–298
 White muscle disease, 377, 380
 Whitmore, H.L., 191, 195
 Whitaker, D.D., 108
 Wichman, H.A., 4
 Wiegant, V.M., 354
 Wierzbowski, S., 20, 31, 168–169,
 172–174, 179, 283, 301
 Wilcox, S., 167
 Willard, J.G., 136
 Willard, J.C., 136
 Williams, M., 35, 78, 80, 101, 110,
 179, 226, 237, 265

- Winchester, C.F., 117
Windsucking (Aerophagia), 48, 368
Winking, 48, 145, 173, 185, 186–187, 190, 281
Withdrawal distance, 61, 255–256
Withers, 12, 40, 77, 157–158, 263, 300, 330, 347
Witherspoon, D.M., 191
Wolff, A., 96, 346
Wolfram, S.A., 136
Wolski, T.R., 25, 31, 208, 221, 298, 301
Wood chewing, 133, 136, 363, 367–368, 384
Wood-Gush, D.G.M., 76, 128
Woods, G.L., 190
Wouters, L., 19, 22, 24
Wright, J.D., 353–354
Wright, J.G., 201, 204
Wysocki, C.J., 29
Yawn, 48, 59, 71, 168, 173, 364, 371
Yeates, B.F., 108, 329, 348
Yoon, Y.M., 131, 136
Zahorik, D.M., 107
Zebra, 3–4, 14, 105–106
Zeeb, K., 93, 132, 163, 218, 255, 257, 265, 267, 330
Zervanos, S.M., 133, 135, 236, 240
Zeuner, F.E., 14–16
Zimmermann, W., 245, 261, 331